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CONTENTS OF VOLUME 45

ANDREW HENRY PATTERSON 1
WILLIAM HOWELL PEGRAM 3
PROCEEDINGS OF THE TWENTY-EIGHTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE 5
A FOREST POLICY FOR NORTH CAROLINA. *J. S. Holmes* 28
POLLEN ANALYSIS OF DISMAL SWAMP PEAT. *Ivey F. Lewis* and *E. C. Cocke* 37
FLORA OF THE TRYON REGION. PART IV. *Donald Culross Peattie* 59
THE HABITS OF THE BLACK-NOSED DACE, RHINICHTHYS ATRONASUS (MITCHILL). *Jay R. Traver* 101
THE RELATIONSHIP OF MICROSTROMA JUGLANDIS (BERENG.) SACC. *Frederick A. Wolf* 130
SWEET POTATOES INFECTED BY SCHIZOPHYLLUM COMMUNE. *R. F. Poole* 137
AEOLIAN SAND AND OIL-BEARING STRATA IN SAKHALIN. *Collier Cobb* 140
THE DISTRIBUTION OF SUGAR IN THE BLOOD OF FISHES. *I. E. Gray* and *F. G. Hall* 142
DISTILLATION PRODUCTS OF CELLULOSE. *H. B. Arbuckle* and *H. S. Davidson* 147
A CATALOG OF THE BIRDS OF DURHAM COUNTY, NORTH CAROLINA. *Ernest Seeman* 150
NOTES ON FUNGI. *W. C. Coker* 164
PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY 179
A PARASITIC ALGA, CEPHALEUROS VIRESCENS KUNZE, ON CITRUS AND CERTAIN OTHER PLANTS. *Frederick A. Wolf* 187
OBSERVATIONS ON MATING HABITS OF CYCLOPS. *L. L. Hill* and *R. E. Coker* 206
THE ECOLOGY OF THE INTERNAL PARASITES OF NIGERIAN RODENTS AND INSECTIVORES. *A. S. Pearse* 221
FURTHER OBSERVATIONS ON ASCIDIAN BLOOD. *W. C. George* 239
FLORA OF THE TRYON REGION. PART V. *Donald C. Peattie* 245
VEGETATION OF THE BLACK MOUNTAINS OF NORTH CAROLINA: AN ECOLOGICAL STUDY. *John H. Davis, Jr* 291
A TAXONOMIC AND MORPHOLOGICAL STUDY OF SOME MEMBERS OF THE SAPROLEGNIACEAE. *James Vernon Harvey* 319
NORTH CAROLINA SCIENTISTS. *Roland M. Harper* 333
FUTURE OF THE OYSTER IN NORTH CAROLINA. *R. E. Coker* 338

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ANDREW HENRY PATTERSON

Andrew Henry Patterson was born September 28, 1870, at Salem, N. C. He was matriculated at the University of North Carolina in 1887 and in 1891 was graduated with the degrees of Bachelor of Philosophy and Bachelor of Engineering. During his student days, he manifested the same wide interest in human affairs which was so characteristic of him in later life. A student of exceptional ability, he still found time to take an active part in the religious life of the community, in intercollegiate athletics, and in the work of numerous college organizations. He was the recipient of many honors within the gift of his fellow students.

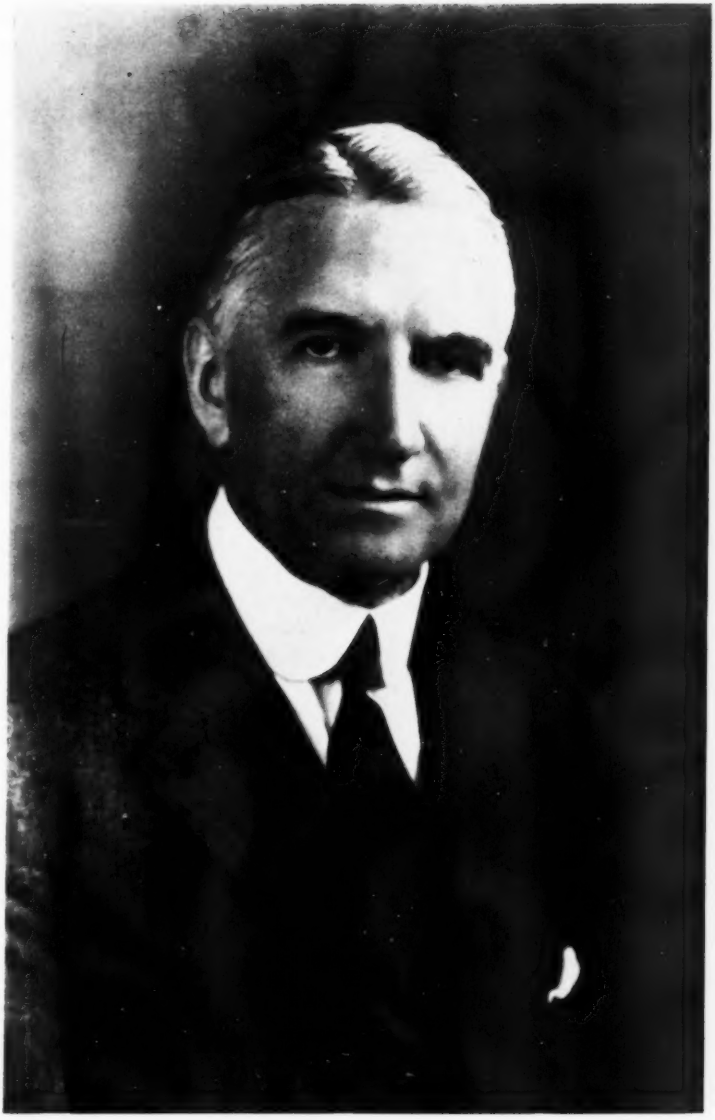
In 1893, he received the degree of Master of Arts from Harvard University, and in 1894 became a member of the faculty of the University of Georgia, where he rose steadily in rank, until in 1898 he was made head of the Department of Physics and Astronomy. After two years of study in Berlin, Charlottenburg Tech. Hochschule, and Cambridge, he returned to the University of North Carolina in 1908 as Professor of Physics, and in 1911 was made Dean of the School of Applied Science. Both of these offices he held at the time of his death on September 9, 1928. He was married in 1897 to Miss Eleanor Alexander, daughter of Eben Alexander, for many years Professor of Greek in the University of North Carolina, and is survived by his wife and two children, Dr. Howard Patterson of New York City, and Mrs. Samuel Fisher of Asheville, N. C. He was a Fellow of the American Physical Society and in 1920 was President of the North Carolina Academy of Science. His contributions included studies in X-rays, high tension phenomena, lightning discharges, and atomic structure.

Dean Patterson was deeply interested in many phases of university life. To his own department of study he gave his best thought, but he also responded heartily to the demands made upon him for service in other agencies. He was a member of many of the most important faculty committees and his unfailing sympathy and understanding gained for him a large number of friends among both students and faculty. He was a devout member of the Episcopal Church and served for many years as senior warden of the Chapel of the Cross in Chapel Hill. The recent expansion of the property of the church was due, in large measure, to his efforts.

Endowed with a character and personality that inspired trust and confidence and always showing an eager willingness to give his best efforts whenever and wherever needed, his whole life was devoted to unselfish service to others.

Committee from the North Carolina Academy of Science,

C. S. MANGUM,
BERT CUNNINGHAM,
C. M. HECK.



ANDREW HENRY PATTERSON

WILLIAM HOWELL PEGRAM

It is fitting that record be made of the passing of Dr. William H. Pegram, and that some account of his life and work be given.

William Howell Pegram was born April 18, 1846, at Chalk Level, in Harnett County, North Carolina. He grew up on his father's farm, and in 1863 joined the Confederate army. At the close of the war, he began to prepare himself for college, and in January, 1869, he entered Trinity College as a student. From that time on he was actively identified with that institution [Trinity College and Duke University] to the day of his death, which occurred April 30, 1928. Dr. Pegram was graduated with the class of 1873. The following year he was tutor in natural science. In 1874 he was elected professor, and took over the work of teaching chemistry, geology, and astronomy. Later his work was narrowed to one field, and the Trinity catalog of 1900 records him as Professor of Chemistry. At the commencement of 1917 he was awarded the Degree of Doctor of Laws by his Alma Mater, and in 1919 he was made Professor Emeritus.

Dr. Pegram was at one time chairman of the faculty of the college, and was its secretary for over thirty years.

Dr. Pegram was married in 1875 to Miss Emma L. Craven, daughter of Braxton Craven, first President of Trinity College. The sons and daughters of this family are known and respected citizens of the nation, one of them being Dr. George B. Pegram, Dean of the School of Applied Sciences in Columbia University.

In 1889 Professor Pegram was elected to membership in the Elisha Mitchell Scientific Society. When the North Carolina Academy of Science was formed in 1902 he was among the first elected members, and was chosen as its president for the year 1911. He never lost interest in the work of the Academy and remained an active member on its roll to the very last.

Dr. Pegram was a man of wide reading and scholarly tastes. At the same time he was thoroughly scientific in his attitude toward truth. He thought clearly and accurately, giving painstaking care to his studies as well as to his teaching.

It was in the field of teaching, however, that Dr. Pegram was at his

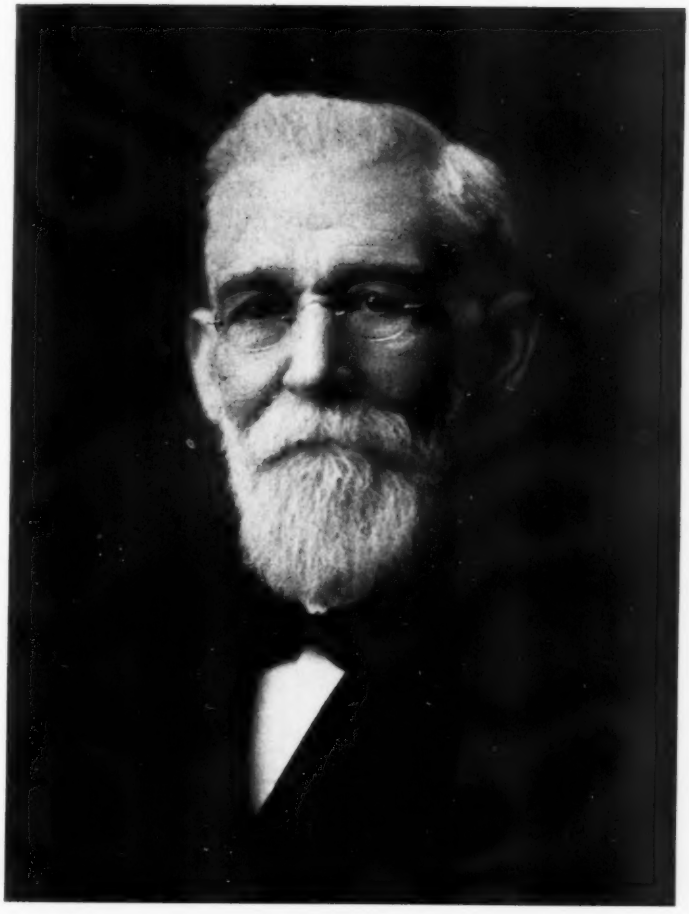
best. He was a careful demonstrator. His experiments did not go wrong. He was intellectually honest to a high degree. Above all he had the power of clear and convincing statement. True to his calling, he was personally interested in his students, and gave himself unstintedly in their behalf. At the same time his enthusiasm for science was stimulating and inspiring.

Dr. Pegram was a forward-looking man. He believed in the future of his state, both in things material and intellectual. He was also a man who had the grace of gentleness and the gift of sympathy; a man of confidence and self-valuation without obtrusiveness. One of his friends has said, "He cared not for controversy . . . . he was all for Science and all for Religion because he was fundamentally all for Life. Scientist by profession, in sympathies and the practice of a lifetime the friend and aider of all those who would live in the spirit."

In him science found a disciple apt and faithful, and in him youth found a wise leader and understanding friend.

Committee from the North Carolina Academy of Science,

R. N. WILSON,
Z. P. METCALF,
H. B. ARBUCKLE.



William Howell Pegram

PROCEEDINGS OF THE TWENTY-EIGHTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE

NORTH CAROLINA COLLEGE FOR WOMEN, MAY 10 AND 11, 1929

The twenty-eighth annual meeting of the North Carolina Academy of Science was held at the North Carolina College for Women, Greensboro, N. C., May 10 and 11, 1929. The meeting was called to order at 10:30 a.m. by President Holmes. The president appointed the following committees:

Auditing—Earl H. Hall, H. L. Blomquist, Ivan V. Shunk.

Nominating—J. R. Givler, H. B. Arbuckle, Collier Cobb.

Resolutions—W. C. George, D. B. Anderson, W. L. Porter.

The reading of papers was begun and continued until 12:40 p.m., when the Academy adjourned for luncheon as guests of the North Carolina College for Women.

The reading of papers was resumed at 2:30 p.m. and continued until 4:30 p.m., when the Academy went into business session.

The minutes of the previous meeting were approved as published in the Journal of the Elisha Mitchell Scientific Society.

Reports were called for from the various committees.

The Executive Committee, consisting of J. S. Holmes, President of the Academy, Miss Mary Petty, Vice-President, H. R. Totten, Secretary and Treasurer, J. W. Nowell, F. A. Wolf, and W. C. George (elected by the Executive Committee to fill the unexpired term of A. H. Patterson, deceased), reported as follows:

"The Executive Committee met at Greensboro, May 9 and again on May 10, with all members present.

"The Committee advanced the paper of George S. Avery, Jr., to the seventh position on the program. All other requests for advancement of papers were refused.

"The Committee reports as elected to membership since the last annual meeting the following:

Barton, Helen, Professor of Mathematics, North Carolina College for Women.

Beaumont, J. H., Professor of Horticulture, State College.
Bender, J. A., Instructor in Pharmacology, University of North Carolina.
Blair, W. W., Instructor in Chemistry, Greensboro High School.
Bost, R. W., Assistant Professor of Chemistry, University of North Carolina.
Brooks, F. P., Assistant Professor of Physiological Chemistry, University of North Carolina.
Brown, J. B., Student in Biology, Elon College.
Bullard, Lena E., Head of Science Department, Greensboro High School.
Cameron, E. A., Teaching Fellow in Mathematics, University of North Carolina.
Davison, Wilburt C., Dean of the School of Medicine, Duke University.
Davidson, A. B., Jr., Instructor in Physics, Davidson College.
Deviney, Ezda M., Research Assistant in Zoology, University of North Carolina.
Ehrlich, John, Graduate Student in Botany, Duke University.
Foster, Norman B., Professor of Physics, North Carolina College for Women.
Fulton, B. B., Research Professor of Zoology, State College.
Garren, G. M., Cereal Agronomist, State College.
Harbison, T. G., Botanical Collector, Highlands, N. C.
Harris, Mildred, Assistant Professor of Hygiene, North Carolina College for Women.
Hayes, Nelson A., Professor of Science, Campbell College.
Hefley, Harold M., Student in Zoology, Duke University.
Jenkins, W. A., Graduate Student in Botany, Duke University.
Kaston, B. J., Student in Zoology, State College.
Lindsey, J. B., Principal Assistant Engineer of the Atlantic Coast Line Railroad Company, Wilmington, N. C.
Littlefield, J. Chester, Instructor in Physics, North Carolina College for Women.
Lothery, Thomas E., Jr., Instructor in Physics, Davidson College.
Love, James Lee, Retired Professor of Mathematics, Burlington, N. C.
McDearman, Ella B., Instructor in Chemistry, North Carolina College for Women.
Mast, Dewey R., Instructor in Zoology, Elon College.
O'Donnell, Annie, Associate Professor of Hygiene, North Carolina College for Women.
Piland, J. R., Graduate Student in Chemistry, State College.
Pomeroy, J. C., Professor of Physics, North Carolina College for Women.
Raper, Kenneth B., Assistant in Botany, University of North Carolina.
Reynolds, J. Paul, Graduate Student in Zoology, University of North Carolina.
Root, Raymond W., Fellow in Zoology, Duke University.
Rotha, Louise Knight, Teacher of Chemistry and Biology, Kinston, N. C.
Schaible, Valerie M., Acting Head of the Department of Mathematics, Salem College.

Slater, Florence W., Lecturer at Large, Winston-Salem, N. C.
Shepard, F. C., Teacher in Greensboro High School.
Smith, Frank Houston, Assistant Chemist in the Nutrition Division, State Experiment Station.
Ward, Rebecca, Graduate Student in Botany, University of North Carolina.
Whitted, Margaret O., Assistant in Biology, Queen's College.
Wilkins, Walter E., Acting Professor of Chemistry, Mars Hill College.
Zever, Karl E., Professor of Psychology, Duke University.

Reinstated to Membership:
Davis, John H., Jr., Associate Professor of Botany, Davidson College.
Gross, P. M., Professor of Chemistry, Duke University.
Lyon, Mary, Professor of Biology, Greensboro College.
Schaeffer, Florence L., Professor of Chemistry, Greensboro College.
Stuhlman, Otto, Jr., Professor of Physics, University of North Carolina.
Wood, W. W., Professor of Mathematics, Davidson College.

The Committee reports the following losses:

By Death:
Patterson, A. H., Dean of the School of Applied Science and Professor of Physics, University of North Carolina.
Pegram, W. H., Professor Emeritus of Chemistry, Duke University.

By Resignation:
Carrington, George L., Surgeon, Burlington, N. C.
Patterson, P. M., Graduate Student in Botany, Johns Hopkins University.
Thompson, H. T., Executive of Boy Scout Work, Kinston, N. C.
Warren, R. M., Science Teacher in Winston-Salem High School.

Dropped for Non-Payment of Dues:
Buffalo, Norman B.; Gordon, Annie; Griffith, B. W.; Hardy, J. D.; Hoyle, V. A.; Kopf, Minnie; Linker, J. B.; Marion, S. J.; Ruggles, C. A.; Schiffman, C. D.; Smithey, S. J.; Snyder, V. E.; Summerell, Francis P.; Wilkerson, N. F.; Williams, J. H.

The Committee made the following recommendations to the Academy:

1. "That all bills presented in the Treasurer's report be authorized and paid and that the report be printed when audited.

2. "That H. B. Arbuckle be appointed a committee of one to select the cup to be given to the winner of the High School Science Essay Prize, and that he be authorized to draw upon the treasury for as much as $25.00 for the cup. That the Academy send a representative to the High School Commencement of the Lexington High School to deliver this Academy prize to the winner. And that the Secretary be

authorized to select the Academy representative and to pay him the expense of his trip from the Academy funds.

3. "That the Academy accept the invitation from Duke University to hold the twenty-ninth annual meeting of the Academy in Durham."

The recommendations of the Executive Committee were adopted. The report of the Executive Committee was adopted.

The Committee on High School Science, consisting of R. N. Wilson, chairman, B. W. Wells, C. M. Heck, C. E. Preston, Bert Cunningham, and H. R. Totten, made the following report:

1. "That the Committee has held one meeting.

2. "That a number of the members of the Committee have met with various district meetings of the North Carolina Education Association in the high school groups, and appeared on group programs.

3. "That the Committee has conducted a state wide science essay contest, along the same lines as in former years. There were thirty-eight essays submitted and the special committee composed of Dr. B. W. Wells, Dr. Carleton E. Preston, and Dr. H. L. Blomquist, has awarded first place to Miss Lila Aaron of the Lexington High School for her essay on Community Health. Mention is also made of two contestants, Miss Christine Shepherd of the Greensboro High School and Miss Fannie Porter Cowles of the Lexington High School.

4. "The Committee recommends that the prize be continued next year and that certain more definite regulations governing the contest be set up by the incoming committee, for the sake of improving its general effectiveness."

The report of the High School Committee was accepted.

The Resolutions Committee submitted the following report:

"Your Resolutions Committee suggests:

1. "That the Academy express its deep sense of loss at the death during the past year of two of its members and former presidents, Dr. W. H. Pegram, Professor Emeritus of Chemistry at Duke University, and Professor Andrew Henry Patterson, Dean of the School of Applied Science and Professor of Physics at the University of North Carolina. Professor Pegram was a member of the Academy throughout its history and served as president in 1911. Professor Patterson was president in 1920 and for many years has been active in advancing the welfare and usefulness of the Academy.

"That copies of this resolution be sent to the families of these two deceased members.

2. "In view of the proposed increase in the tariff on scientific instruments be it resolved:

"That the North Carolina Academy of Science register its protest to this proposed legislation since it would place a further handicap upon education and scientific research in this country. Furthermore, that we urge a return to the tariff laws providing for duty free importation of scientific instruments for educational institutions.

"That the Secretary be instructed to send copies of this resolution to the Chairman of the Committee on Ways and Means, the Chairman of the Senate Finance Committee and to the senators and congressmen representing North Carolina in Washington; and that the Secretary be instructed to request endorsements of this resolution from all the colleges and universities in the state.

3. "We wish to express to President Foust, to the local committee on arrangements, and to the North Carolina College for Women our appreciation for their hospitality in entertaining the twenty-eighth annual meeting of the North Carolina Academy of Science."

W. C. GEORGE,
D. B. ANDERSON,
W. L. PORTER, *Committee.*

The first and third resolutions were adopted by rising votes, and the second by acclamation.

The auditing committee reported that it had examined the financial accounts of the Secretary-Treasurer covering the period April 25, 1928, to May 8, 1929, and found them correct.

The report of the Auditing Committee was accepted and the Treasurer was instructed to print the financial statement.

The Treasurer's report was called for and was presented as follows:

Financial Statement

Receipts		Expenditures	
Balance on hand, April 25, 1928.	$677.62	Stationery, postage and express	$68.79
Dues, for			
1928	84.00	Printing, mimeographing and addressographing	116.40
1929	300.00		
1930	2.00	Telegrams and phone calls	2.87
Receipts		**Expenditures**	
Initiations, at 1928 Meeting	$38.00	Journal of the E. M. S. S.	$200.00
Since 1928 Meeting	64.00	Clerical assistance	78.03
Chemists' programs	5.00	High School Science Prize	25.00

Allotments from A. A. A. S.		Sec'y-Treas. commission	$48.60
For 1928	$50.50	Dues refund to Sec'y-Treas.	2.00
For 1929	50.00	Refunds to A. A. A. S	1.00
Replacing protested checks and protest fees	4.50	Protested checks and protest fee	6.50
Interest on savings	18.61		
			$549.19
	$1294.23	To balance	745.04
			$1294.23

Comparison

	1928	1929
Savings account	$458.91	$477.52
Checking account	184.71	252.52
Cash on hand	34.00	15.00
	$677.62	$745.04
To balance	67.42	
	$745.04	

The above report was made as of May 8, 1929.

Submitted by

H. R. Totten, *Secretary-Treasurer.*

Audited by

Earl H. Hall,

H. L. Blomquist,

I. V. Shunk.

The Treasurer's report was accepted.

The Nominating Committee made the following nominations: President, J. B. Derieux, State College. Vice-President, J. B. Bullitt, University of North Carolina. Additional member of the Executive Committee, for three years, Bert Cunningham, Duke University. Representative to the Council of the American Association for the Advancement of Science, for a period of two years, W. C. Coker, University of North Carolina.

The Secretary was instructed to cast the vote of the Academy for those nominated by the Nominating Committee.

Bert Cunningham, the representative to the American Association Council for the past year, reported as follows:

"Your representative to the American Association Council attended all of the meetings of the Council in New York and also the Academy Conference. With the exception of the increase in certain budgets the Council attended to routine business. This may be found in the Permanent Secretary's Report.

"The Academy Conference discussed in a general way such questions as membership in academies, and academy publications, but the chief discussion centered around 'The Relation of the Academy to the American Association.' The discussion was led by Dr. M. W. Lyon, Jr., and was quite profitable.

"The general plan of advancing the Secretary to the Presidency was adopted. The preliminary ballot for Secretary was disregarded and since the Association was to meet in Des Moines, D. W. Morehouse of Drake was elected Secretary of the Conference."

The report of the Academy's representative was accepted.

R. F. Poole, President of the Southern Group of the American Phytopathological Association, announced to the Academy that the American Phytopathological Association would meet with the Southern Group this summer in North Carolina.

J. B. Derieux, F. A. Wolf, and W. C. Coker were instructed to represent the Academy at the American Phytopathological meeting.

Bert Cunningham moved that the Academy pay to the *Journal of the Elisha Mitchell Scientific Society* $300.00 during the coming year for publishing the Proceedings of the Academy and for subscriptions of Academy members.

The motion was carried.

The following committees for the coming year were appointed:

Committee on High School Science: R. N. Wilson of Duke University, Chairman; C. M. Heck of State College; H. B. Arbuckle of Davidson College; Bert Cunningham of Duke University; and Miss Lena Bullard of the Greensboro High School.

Legislative Committee: Z. P. Metcalf of State College, chairman; W. L. Poteat of Wake Forest College; and H. H. Brimley of the State Museum.

The Business Meeting of the Academy was adjourned and the rest of the afternoon was given over for tours of the exhibits.

The Academy reconvened at 8:30 p.m. with Vice-President Mary Petty presiding. J. P. Givler, Chairman of the North Carolina College for Women Science Group, welcomed the Academy to the North Carolina College for Women. President J. S. Holmes responded for the Academy and then delivered the presidential address on "A State Forest Policy for North Carolina."

E. W. Gudger, Secretary-Treasurer of the Academy from 1908 to 1918 and President in 1919, meeting with the Academy after an absence of ten years, was welcomed back heartily by the Academy and

was called upon for a talk. He reviewed some of the early struggles of the Academy; congratulated the Academy and the State of North Carolina on the progress made during the last ten years; and told something of his work in the American Museum of Natural History.

After this a reception was given the Academy by the North Carolina College for Women.

The Academy convened in sections Saturday morning with President Holmes presiding over the general section group; L. G. Willis, over the chemists; J. W. Lasley, over the mathematicians; and W. T. Wright, over the physicists.

The following group officers were elected by the groups concerned for the year 1929–30:

Chemistry, Frank K. Cameron of the University of North Carolina, chairman; O. J. Thies, Jr. of Davidson College, vice-chairman; L. B. Rhodes of the North Carolina Department of Agriculture, secretary-treasurer; and F. W. Sherwood of the State Experiment Station, councillor.

Mathematics, Helen Barton of the North Carolina College for Women, chairman; W. W. Elliott of Duke University, secretary.

Physics, Otto Stuhlman, Jr., of the University of North Carolina, chairman; G. B. Collins of Duke University, secretary.

The following papers were presented. Those marked with an * appear in full in this issue; those marked x are abstracted in this issue; for those unmarked no abstracts have been received; those marked † were presented by title only.

GENERAL SECTION

A Preliminary Report on an Ephebe Type of Lichen. EARL H. HALL, N. C. C. W.

x *Further Investigation of Infra-Red Sterility* (Lantern). BERT CUNNINGHAM and DOROTHY SCHALLERT, Duke.

Some Factors Governing the Rate of Penetration of Pulp Liquor. E. E. RANDOLPH, State.

* *Aeolian Sand and Oil-bearing Strata in Sakhalin.* COLLIER COBB, U. N. C.

The Development of the Gametophyte of the Venus Fly Trap. H. L. BLOMQUIST, Duke.

x *Nitrogen-Fixation in a Grass-Sedge Bog.* IVAN V. SHUNK, State.

Embryo and Seedling Structure of Certain Economic Grasses (Lantern). GEO. S. AVERY, JR., Duke.

x *Some Impressions of a Layman on Science and Scientists.* REV. GEO. W. LAY, Chapel Hill.

x *An Experimental Study of Spatial Orientation* (Opaque projector). J. F. DASHIELL, U. N. C.

x *Dissemination Activities of Monilochaetes infuscans* (Lantern). R. F. POOLE, State.

Areolate Mildew of Cotton (Lantern). JOHN EHRLICH, Duke.

x *The Height-Distribution of Bursting Bubbles due to Effervescence* (Lantern). OTTO STUHLMAN, JR., and HENRY ZURBURG, U. N. C.

Further Observations on the Relationship between Septobasidium and Scale Insects (Lantern). J. N. COUCH, U. N. C.

The Oxygen Consumption of Three Marine Fishes (Lantern). F. G. HALL, Duke.

A Pug-Headed Sea Bass. E. W. GUDGER, American Museum.

x *The Growth Habit of Diplocarpon rosae in Relation to the Structure of the Epidermal Cell Wall of Rose Leaves* (Lantern). D. B. ANDERSON, State.

Cherry Leafspot (Lantern). W. A. JENKINS, Duke.

† *Cedarwood Oil Production in North Carolina* (Lantern). E. V. KYSER, U. N. C.

x *A Sub-Alpine Plant Association of the Craggy Range, N. C.* (Lantern). JOHN H. DAVIS, JR., Davidson.

x *The "Open Grounds" of Carteret County, N. C.* (Lantern). B. W. WELLS, State.

x *The Algae of Lake Raleigh: An Ecological Study* (Lantern) LARRY A. WHITFORD, State.

A Parasitic Alga (Lantern). FREDERICK A. WOLF, Duke.

x *Water Supplies from Crystalline Rocks of North Carolina.* JASPER L. STUCKEY, State.

† *A Recessive Factor for Polydactylism in Man* (Lantern). L. H. SNYDER, State.

† *Six New Species of Nematodes from Rodents of North Carolina.* HAROLD M. HEFLEY, Duke.

x *The Regeneration of the Epidermis in Sponges Grown from Dissociated Cells.* H. V. WILSON and J. T. PENNEY, U. N. C.

* *Breeding Habits of the Black-nosed Dace, Rhinichthys atronasus* (Lantern). JAY R. TRAVER, N. C. C. W.

A Chapel Hill Species of Pythium Related to Pythium splendens. VELMA MATTHEWS, U. N. C.

Observations on the Shrubby Buckeye of Chapel Hill. REBECCA WARD, U. N. C.

x*The Effect of Nitrogen in Nutrient Medium on Stomatal Movement (Preliminary Report)* (Lantern). ANNIE L. PLEASANTS, N. C. C. W.

†*Vegetation on the Loam-Loess Soils along the Mississippi from Cairo to Baton Rouge.* COLLIER COBB, U. N. C.

x*Further Studies on the Effects of Injecting Substances into Hen's Eggs.* BERT CUNNINGHAM and A. RODRIGUEZ-DIAGO, Duke.

†*The Influence of Humidity on the Body Temperature of Certain Poikilotherms* (Lantern). F. G. HALL and R. W. ROOT, Duke.

x*A Study of the Effect of Temperature on the Occurrence of Hydra in the Elon College Area.* J. B. BROWN, Elon.

EXHIBITS

Aquatic Insects. JAY R. TRAVER, N. C. C. W.

An Ophioglossum Fern Found about Greensboro. EARL H. HALL, N. C. C. W.

Vick's Ingredients from the Far Corners of the Earth. G. A. RUSSEL, Vick Chemical Company.

Flower Show. Local Flora Class of N. C. C. W.

PHYSICS SECTION

x*The Extension, Period, and Modulus of Rigidity of a Spring Wound in the Form of a Truncated Cone* (Lantern). G. D. COLLINS and OLIN B. ADER, Duke.

Infra-Red Absorption Spectra of Some Alcohols. E. K. PLYLER and THEODORE BURDINE, U. N. C.

The Intensity of the Magnetic Field within a Circular Current at Points not at the Center. H. H. BARNEY, State.

x*Relative Intensities of the Mercury Lines* $2^3P_{0,1,2} - 2^3S_1$, *in the Electrodeless Discharge.* M. W. TRAWICK and OTTO STUHLMAN, JR., U. N. C.

Variation of Field Intensity of Certain Wireless Transatlantic Telegraph Stations. J. CHESTER SWANSON, Duke.

x*The Infra-Red Absorption Spectra of Some Organic Nitrates.* E. K. PLYLER and P. J. STEELE, U. N. C.

A Simple Method of Comparing Radio Signal Intensity with the Distribution of Atmospheric Pressure. WAYNE C. GUNTER, State.

Motions of Liquid Dielectric and Suspended Particles in Liquid Dielectrics under Electrostatic Stress. H. BARNEY, State.

Ultra-Violet Radiation Transmitted by Earth's Atmosphere (Lantern). GLADYS WHITE, Duke.

MATHEMATICS SECTION

x*Symmetrical Triples of Involutions (Preliminary Report).* EDWARD T. BROWNE, U. N. C.

Note on Green's Functions. W. W. ELLIOTT, Duke.

x*The Rôle of the Absolute in Geometry.* E. A. CAMERON, U. N. C.

x*On the Osculating Cubic of a Plane Curve.* J. W. LASLEY, JR., U. N. C.

NORTH CAROLINA SECTION OF THE AMERICAN CHEMICAL SOCIETY

**Distillation Products of Cellulose.* H. B. ARBUCKLE and H. S. DAVIDSON, JR., Davidson.

The Bromination of 1, 5-Dihydroxynaphthalene. A. S. WHEELER and D. R. ERGLE, U. N. C.

A Method for Determining the Solubility of Difficultly Soluble Liquids in Water. PAUL GROSS, Duke.

Factors Affecting the Stability of Iodine Solutions. F. H. EDMISTER and H. V. HARSHMAN, U. N. C.

The Occurrence of Copper in Some North Carolina Crops. L. F. WILLIAMS and J. R. PILAND, State.

The System: $CuSO_4$-H_2SO_4-H_2O. H. D. CROCKFORD and L. E. WARRICK, U. N. C.

Grignard Reactions in the Para-Cymene Series. A. S. WHEELER and R. D. NORTON, U. N. C.

Equilibria in the System: Ferric Sulphate, Cupric Sulphate, Sulphuric Acid and Water. H. D. CROCKFORD and F. K. CAMERON, U. N. C.

Tin Tetraphenyl as a Phenylating Agent. R. W. BOST, U. N. C.

Determination of the Pectic Constituents of Apples. L. F. WILLIAMS and H. M. SIGMAN, State.

Estimation of Calcium in Presence of Phosphate Ion. J. T. DOBBINS and W. M. MEBANE, U. N. C.

Estimation of Sulphites in Presence of Arsenites. J. T. DOBBINS and H. A. LJUNG, U. N. C.

Volcanic Ash as an Earthenware Body Ingredient. G. R. SHELTON, State.

Moisture Content of Clays and the Apparent Specific Gravity. R. A. LINEBERRY and F. K. CAMERON, U. N. C.

2-p-Cyml-4-semicarbazide and Derivatives. A. S. WHEELER and J. G. PARK, U. N. C.

Composition of Shrimp Oil. R. F. ABERNETHY and F. C. VILBRANDT, U. N. C.

The Solubility of the Dichloroethanes and Propanes in Water and Salt Solutions. PAUL GROSS, Duke.

The Effect of Sulphur Dioxide on Suspensions of Phosphates of Lime in Water. W. M. MEBANE, J .T. DOBBINS, and F. K. CAMERON, U. N. C.

The Solubility of Ferrous Sulphate in Aqueous Solutions of Sulphuric Acid and Water. E. R. WARD and F. K. CAMERON, U. N. C.

Para-cymylhydrazine and Derivatives. A. S. WHEELER and C. L. THOMAS, U. N. C.

Toluene-4-Carbithoic Acid. R. W. BOST and W. J. MATTOX, U. N. C.

Temperature-Composition Studies of Some Nitrotoluene Mixtures. H. D. CROCKFORD and A. E. HUGHES, U. N. C.

Lipolytic Action with Reference to the Influence of Various Preservatives. F. E. RICE, L. F. WILLIAMS and H. M. THOMPSON, State.

Mixing Studies. I. Highly Ionizable Salts in Non-viscous Media. R. C. MATTHEWS and F. C. VILBRANDT, U. N. C.

p-Bromo-4-phenylsemicarbazide. A. S. WHEELER, U. N. C.

A Proposed Scheme of Separation of the Anions. J. T. DOBBINS and H. A. LJUNG, U. N. C.

Freezing-Point Studies on Solutions of Benzoic Acid in Benzene. J. M. BELL and S. M. MARTIN, U. N. C.

The following abstracts have been received:

Further Studies on Infra-Red Sterility. BERT CUNNINGHAM and DOROTHY SCHALLERT.

Earlier studies[1] indicated that sterility produced by infra-red was probably due to heat effects. Some indication of a cyclic sterility was observed. This has been followed up with some thirty additional animals and sterility found to occur in most of them. As many as three alternations of sterility and fertility were observed following a single five minute treatment of the rat with infra-red.

[1] Cunningham and Osborn. Endocrinology **13**: 93–96.

Nitrogen-Fixation in a Grass-Sedge Bog. I. V. SHUNK.

In studying the microbiology of the soil of an upland grass-sedge bog located in Pender County, North Carolina, it was found that the soil contained 0.24 per cent of total nitrogen. Since this land is never cultivated and no fertilizers are added, the source of this nitrogen must be largely from the atmosphere. No leguminous plants are found on this bog, and the soil is not adapted for the development of *Azotobacter* species on account of its acidity and the anaerobic conditions that prevail for a considerable part of the time. Several attempts to find *Azotobacter* organisms failed. On the other hand, anaerobic nitrogen-fixing bacteria, *Clostridium pastorianum*, were found in this soil, and it was demonstrated that under anaerobic conditions nitrogen was fixed in solutions to which a suspension of the bog soil had been added.

Some Impressions of a Layman on Science and Scientists. GEO. W. LAY.

The paper described the effect of some scientific lectures heard in early youth by one who never specialized in any scientific subject, his belief that everyone should have a fairly good foundation in the sciences, his appreciation of the attractiveness of science and scientists, and offered some suggestions as to how scientists could make themselves more effective in diffusing scientific knowledge.

An Experimental Study of Spatial Orientation. J. F. DASHIELL.

Rats were trained in an open-alley maze offering a great number of criss-crossing alternative and equal-length pathways from the entrance to the food-box exit. Each animal learned early to adjust to the situation not by fixating some particular pathway but by running in the general direction of the exit now by one succession of turns and now by another, so that in a series of trials it followed a variety of courses from entrance to exit—each course being followed without error and each without any previous practice therein. Thus the animal's learning consisted in the establishing not of a definite pattern of specific turns but of some more general orientation function. This general function enabled it to pursue new pathways while remaining successfully oriented toward the objective. In the course of repetitions of the experiment, exteroceptive cues (visual, auditory, and olfactory both from without and from within the maze) were eliminated by rotations, shuffling of construction units, air currents, etc.; leading to the conclusion that the performance must be controlled intra-organically.

What can be the precise nature of this general function? Classical

theories of homing are canvassed and discarded. An interpretation is offered for consideration in terms of initially established motor sets and of compensatory tendencies. Support for some such explanation is furnished by further experiments in which the animal is introduced into the maze from different directions, and behaves consistently with these new directions of original set; also from data obtained incidentally in other types of maze experiments.

Dissemination Activities of Monilochaetes infuscans. R. F. POOLE.

The *Monilochaetes infuscans* fungus and the scurf disease which it causes on sweet potatoes have been well described. The spreading activities of the fungus on the plant and potato have not been thoroughly explained. Aside from the scientific interest the information obtained on the dissemination activities of this fungus has a bearing on the practical significance of its control.

The fungus lives over on the epidermis of the sweet potato. If diseased potatoes are bedded in rich loamy soil the rootlets and stem become infected during the period required for germinating and developing the plant. The fungus develops through the soil medium and upward on the plant, by extension of mycelium and hyphae. If bedded in sand the basal part of the sprout only may become infected, but if left on the potato for an extended period the entire rootlet and stem part of the sprout may become diseased, because the mycelium spreads slowly in all directions. A similar condition occurs when diseased plants are transplanted in rich loamy and sandy soils.

The spread is downward from infected stems to the potatoes, which are produced laterally or below the stem. The growth of the fungus along the stem slowly advances the disease to parts adjacent to the infected stem, but spores, which are produced in abundance on the stem throughout the growing season, reach the potato when the soil becomes cracked during the formation of the potato and during rain periods. The latter means of spread is the most important. This results in the greatest amount of infection taking place on the parts nearest to the infected stem, and especially on potatoes immediately beneath the stem. Potatoes arising above the infected stem frequently remain free of scurf. Those below on the same plant are often completely infected.

The Height-Distribution of Bursting Bubbles due to Effervescence. OTTO STUHLMAN, JR., and HENRY ZURBURG.

Any gas dissolved in distilled water at a given pressure and tempera-

ture will effervesce when heated to a higher temperature. The bubbles pass through the surface and burst into fragments dragging some of the liquid with them. The trajectories of the bursts were photographed and classified according to the heights of their ascensions. From gas kinetic considerations it can be theoretically shown that

$$\frac{RT}{N} \log \frac{N_0}{N} = \frac{4}{3} \pi r^3 (D - d) hg$$

where the log of the number of bubbles reaching a height h and distributed between h and h + dh is proportional to the height of their ascensions. Bubbles burst on the average either into two or more fragments, each group of fragments distributing itself according to an approximate Maxwellian curve having a velocity component perpendicular to the surface of the liquid.

The growth habit of Diplocarpon rosae in relation to the structure of the epidermal cell wall of rose leaves. D. B. ANDERSON.

The vegetative body of *Diplocarpon rosae* consists of two mycelia, one living between the cuticle and the outer epidermal cell wall; the other penetrating the mesophyll of the leaf. Microchemical studies of the epidermal cell wall show the presence of a layer of pectic material between the cuticle and the inner cellulose layer. Tests with polarized light confirm the presence and position of this pectic layer. The subcuticular mycelium of the fungus develops in this pectic layer.

A Sub-Alpine Plant Association of the Craggy Range, N. C. JOHN H. DAVIS, JR.

A very typical sub-alpine association of the northern hardwood type has been studied in some detail along the Craggy Range adjacent to Mt. Mitchell. This association which is known locally as an "orchard" is composed of tree species of definite sub-alpine growth form. The dominants *Fagus grandifolia, Betula lutea, Aesculus octandra* and *Crataegus punctata* are dwarfed and asymetrical and quite different from the same species at lower elevations.

Studies of this association type and of the "Bald" type afford a possible explanation of the latter which has been such a problem to ecologists in this and other mountain regions.

The "Open Grounds" of Carteret Co., N. C. B. W. WELLS.

This area is a fire-repressed shrub bog comprising approximately

50,000 acres. The dominant shrub is *Cyrilla racemiflora*. Subdominants are *Zenobia cassinifolia*, *Pieris nitida* and *Tamala Borbonia*. Other plants which are common are *Anchistea virginica*, *Aronia arbutifolia*, *Ilex lucida*, *Gordonia lasianthus*, *Kalmia angustifolia*, *Magnolia virginiana*, and *Pinus serotina*. On the border transition zone, *Arundinaria* is commonly dominant.

Four to five feet of peat is found which according to Dr. A. P. Stokes of the Bureau of Soils, U. S. Dept. of Agriculture, exhibits three strata (1) a basal brown fibrous layer, with logs of *Chamaecyparis thyoides* on top of it and buried under (2) a middle homogeneous layer of black sticky peat and (3) a surface layer of coarse imperfectly decayed woody peat.

The plant succession following the almost total destruction of the shrubs by intense fire, begins with *Erechtites hieracifolia* and *Solidago fistulosa*. These are followed by *Andropogon glomeratus* which in turn will give way to the bog complex in which the pocosin pine may at first be prominent.

On the margin where the peat is thinner the more mesic vegetation resists fire with the result that the pine trees here are older and taller and form a natural boundary for the bog. At only one point on the east side has fire, aided by the prevailing westerly wind, been able to destroy the tall tree enclosure.

A million dollar drainage development on the area has failed. Many factors contributed to this, among which may be mentioned: difficulty of breaking the shrub cover, plastic and impervious nature of middle peat layer making impossible satisfactory drainage, peculiar nature of surface peat and fire.

The Algae of Lake Raleigh: An Ecological Study. LARRY A. WHITFORD.

The study is based on collections made at bi-weekly intervals from October 1927 to October 1928 at Lake Raleigh one of the water supply reservoirs of the City of Raleigh, N. C. In order of their abundance the most abundant genera of algae were: *Oedogonium*, *Spirogyra*, *Desmidium*, *Cosmarium*, *Hyalotheca*, *Staurastrum*, *Closterium*, *Gymnozyga*, *Lyngbya*, and *Mougeotia*. The chief environmental factors, such as temperature, sunshine, height of lake, pH, dissolved O and CO_2, and the concentration of dissolved solids, were studied. The presence or absence of a species at a particular place and its abundance where found depend upon the chance of its having been introduced as well as upon the environmental factors which obtain there. The vegetative abundance

of a species at any one time depends upon both internal hereditary factors and environmental conditions; chiefly the first in case of the annuals and more the last in case of the perennials and ephemerals. According to periodicity the following groups were found: (1) Spring Annuals, (2) Summer Annuals, (2) Autumn Annuals, (4) Perennials, (5) Ephemerals, and possibly (6) Winter Annuals. The times of fruiting are not the same as for the same species further north but are earlier in the spring or summer and later in the autumn. The time of greatest general abundance is in the spring (March to May). The unicellular desmids, however, are most abundant in summer and the blue-greens in late summer and autumn.

Water Supplies from Crystalline Rocks of North Carolina. JASPER L. STUCKEY.

Until recently it has been believed by many that water could not be obtained from crystalline rocks except in small amounts. Developments during the last few years are demonstrating that supplies sufficient for small towns and villages may be readily obtained from such rocks.

Practically all of the piedmont and mountain sections of North Carolina are underlain with crystalline rocks and in these sections many small towns and industrial centers have turned to deep wells for their water supplies. Practice in these sections has shown that when proper care is taken in locating and drilling deep wells the greater number of such wells is successful. A preliminary investigation only partially complete reveals the presence of some 500 deep wells in use at the present time distributed through about forty counties. These wells average 194 feet deep, 6 inches in diameter, and furnish an average of 23 gallons per minute each.

The Regeneration of the Epidermis in Sponges Grown from Dissociated Cells. H. V. WILSON and J. T. PENNEY.

The epidermis of the adult sponge, *Microciona prolifera*, is a continuous sheet of protoplasm which is devoid of cell outlines and in which the nuclei are irregularly scattered. The mesenchyme is composed of eight different types of cells which are recognizable by their nuclei and inclusions. The bulk of the dissociated tissue and of the early reunition masses is made up of two of these types of mesenchyme cells and of collar cells.

The epidermis of the sponges grown from dissociated cells is formed

from mesenchyme cells of a particular type. These cells form a layer at the surface of the early reunition mass. They flatten out, become continuous with one another, and eventually form a thin film in which the inclusions typical of the cells taking part in this formation are arranged in a single layer. These inclusions disappear and the film assumes the adult condition.

The Effect of Nitrogen in Nutrient Medium upon the Stomatal Movement. ANNIE L. PLEASANTS.

Although it seems that little has been published concerning the effect of nitrogen on drought resistance, the works of Briggs and Shantz in various experiments on water requirements of plants indicate, as does that of Montgomery and Kiesselbach, that there may be such a relation. Kiesselbach, as well as Briggs and Shantz, gives evidence that the water requirement of plants is lessened in soils to which nitrogen fertilizers are added. Kiesselbach, however, warns against making the soil too fertile in regions subject to drought for he claims and gives evidence that the total water loss is greater even though the water requirement is lessened, due to additional plant growth.

Dr. O. F. Curtis is of the opinion that even though the total loss may be greater the plant is nevertheless more resistant to drought, suggesting that the stomata may close more effectively when water becomes the limiting factor. The work of Von Seelhorst (1915) according to Morse shows that if nitrogen or phosphorus is the scarce element its addition will likewise produce a more efficient use of water by the plant.

At the suggestion of Dr. O. F. Curtis of Cornell the writer has undertaken this study to determine if there might be a possible relationship between the amount of nitrogen in the nutrient medium and the stomatal movement of plants grown therein.

Seeds of three varieties of legumes: *Phaesolus vulgaris* var. Red Valentine, Burpee Green Pod, and *Pisum sativum* were planted in pots containing builders' sand the last of February. In March seedlings of the same were started in water cultures. The first of May seeds of the above varieties together with *Lactuca sativa* var. Early Prize Head, and *Raphanus sativa* var. Mauler's American Beauty were planted in three nutrient media: Builders' sand, water cultures, and dark loam soil. Duplicates of each of the above have been supplied with modified Knop's nutrient solution with and without nitrogen.

Lloyd's method of obtaining material for examination has been used. it consists of quickly stripping the epidermis and dropping it into abso-

lute alcohol. The epidermis of mature leaves of different plants was stripped from the same position on the leaf March 21, 25, 27, 28, and April 2, 1929. At stated intervals the percentage of closure and average size of approximately thirty stomata was noted. Camera lucida drawings were made of those of April 2, 1929.

To date these rather consistent variations have been noted in the stomata of lower leaf surfaces of the legumes grown with and without nitrogen:

1. The stomatal apertures of those without nitrogen have been noted to be smaller in the forenoon than those grown with nitrogen.
2. The percentage of those remaining closed has been larger during the same period for those grown in the nutrient without nitrogen.
3. A greater individual variation in size of stomata in those grown without nitrogen has been noted.
4. These differences have been observed to be more or less consistent during the life of the plant from mature leaf formation until after fruiting.
5. From data on loss of water vapor from the plants without nitrogen it is indicated that per unit time more water is required by the plants without nitrogen for each gram of dry weight. Also more water has been lost by those plants which have been tested, per square centimeter of leaf surface, per hour, for those grown without nitrogen. These data seem to agree with observations of Briggs and Shantz.
6. It might be suggested, however, that these variations in the stomatal movements of the plants grown under similar conditions may be modified by a longer period of continued sunlight. Also in view of the work of previous investigators on stomatal movement, the variations above noted may not be indicative of the twenty-four hour cycle.

Further Experiments on Injecting Foreign Substances into Hen's Eggs. BERT CUNNINGHAM and A. RODRIGUEZ-DIAGO.

The senior author and W. Stanfield have shown that pituitrin may be injected into the hen's egg without injury to the developing embryo.[1] During the present year additional studies have been made using the separate principles of the pituitary independently. Although the number of cases is too limited to use as a basis for positive conclusions, the evidence indicates that the substances which accelerated the development of the eggs in our earlier experiments was the pressor substance.

[1] Journ. E. M. Sc. Soc. 44 (1): 63-65.

Testicular tissue has also been injected. The fatalities here run high because of the chances of infection. Only a few chicks have been hatched from eggs receiving the injection.

These experiments are to be continued and histological examination is to be made of the tissues and organs of the animals produced under these conditions. It is possible that the testicular tissue may produce conditions similar to free martins in cattle.

A Study of the Effect of Temperature on the Occurrence of Hydra in the Elon College Area. J. B. BROWN.

In the Elon College area, *Hydra vulgaris* and *Hydra viridis* were studied to see if temperature had any effect on their occurrence. It was found that there was a marked correlation existing between the curve for temperature and that of the numbers of hydra found at any particular station. Experiments were run weekly. Minor fluctuations in temperature were not in every case noticed in the hydra variation, but marked changes were represented on the curves for hydra abundance. The curves show that a high temperature, within the limits of this experiment, is conducive for a small number of hydra, while a low temperature results in a greater number.

The Extension, Period, and Modulus of Rigidity of a Spring Wound in the Form of a Truncated Cone. GYFFORD D. COLLINS and OLIN B. ADER.

On the assumpton that the whole of the extension of a spring was due to torsion, the effect of shear being negligible (being about 0.2 per cent in the spring used in this experiment), O. B. Ader has derived an expression for the extension of a truncated conical spring in the following form:

$$z = \frac{2\,Mg\,N\,(R + r)\,(R^2 + Rr + r^2)}{3\,n\,r_1^4}$$

in which z is the extension produced by an axial load Mg, N is the total number of coils in the spring, R and r the radii of the two end coils, n the rigidity modulus, and r_1 the radius of the wire of which the spring is made.

The period of the spring is given by

$$T = 2\pi\sqrt{\left(1 + x\frac{m}{M}\right)\frac{z}{g}}$$

in which x is the fraction of the mass of the spring accelerated, m the mass of the spring, and z the extension produced by the load M. The fraction x varies from 1/7 in a conical spring (r equal to 0) to 1/3 in the helical spring (r equal to R).

The rigidity modulus may be calculated from

$$n = \frac{8\,\pi^2\,M\,N\left(1 + x\,\frac{m}{M}\right)(R + r)\,(R^2 + Rr + r^2)}{3\,r_1^4\,T^2}$$

where the symbols have the same meaning as above. All these expressions have been checked experimentally with good agreement. Further, the period is noticeably different when the spring is inverted, due to the difference in the fraction of mass accelerated, since all the other factors are constant. In the spring used the fraction was 0.2034 when the small end was up, and 0.5075 when inverted, the mass of the spring was 67.091 gms., and the load varied from 50 to 450 gms.

Relative Intensities of the Mercury Lines $2^3P_{0,1,2} - 2^3S_1$ in the Electrodeless Discharge. M. W. TRAWICK and OTTO STUHLMAN, JR.

The electrodeless discharge was obtained in a spherical glass globe, 12 cm. in diameter at 20 microns pressure using a damped high frequency oscillating circuit with pancake coil emitting a 200 meter wave. The spectograms were obtained with a Gaertner spectograph and analyzed with a Moll microphotometer. The intensities of the lines 5461, 4358 and 4047 as excited in this discharge were compared with similar wavelengths excited in the high pressure mercury vapor lamp.

COMPARATIVE INTENSITIES
E = electrodeless, A = Arc

WAVELENGTHS	RATIO OF INTENSITIES $\frac{E}{A}$	FRAY AND MONTGOMERY	P
5461 E 5461 A	1.0	1.0	1.0
4358 E 4358 A	1.4	6.0	1.2
4047 E 4047 A	1.2	1.8	0.3

For comparison, the table includes results obtained by Fray and Montgomery at a pressure of the order of 1 micron and with a 3 meter wavelength. Column P gives the ratio of the probabilities of the transitions obtained by White from voltage-intensity relations, i.e., the number of quanta emitted for an accelerating voltage of 10.2 volts in mercury vapor at about 230°C.

The Infra-Red Absorption Spectra of Organic Nitrates. E. K. PLYLER and P. J. STEELE.

The infra-red absorption of four organic nitrates has been studied in the region from 1.0 to 7.5μ. The liquids used are methyl nitrate, ethyl nitrate, propyl nitrate, and butyl nitrate. Two absorption bands are attributed to the OH linkage. All other are attributed to the carbon-hydrogen linkage. As an additional CH_2 group is introduced, two characteristics appear, namely, the intensity of all bands decreases and a shift of from .01 to .06μ to longer wave length occurs. No characteristic absorption spectra of the NO_3 group has been found. Investigators have found that the carbon hydrogen linkage gives regions of intense absorption at 3.43, 6.86, 13.6 to 13.8 and 14μ. Fundamental frequencies are obtained in these regions. The other bands are obtained by a combination of these fundamentals. The calculated bands check within experimental error with the observed bands. The general band spectra formula, $NV_1 = NV_0(1 - nx)$, is used in the calculations of bands.

Symmetrical Triples of Involutions. EDWARD T. BROWNE.

We consider three non-scalar matrices A, B, C of even order $n = 2p$ which satisfy the following conditions

$$A^2 = B^2 = C^2 = I;$$
$$D_i = E_i = 0;\ F_i \text{ of rank } p \ (i = 1, 2, 3).$$

Here I is the Unit Matrix and D_1, E_1, F_1 are defined by the relations

$$D_1 = AB + BA + 2I,$$
$$E_1 = (A + I)(B + I),$$
$$F_1 = (B + I)(A + I);$$

D_2, D_3, etc., being derived from D_1, etc., by cyclic interchanges on A, B and C. Such matrices A, B, C are the matrices of what we shall call a *symmetrical triple of involutions.* They possess among other properties the property that if U is any linear combination of them of the form

$$U = \alpha A + \beta B + \gamma C,$$

then $U^2 = kI$, where $k = (\alpha - \beta + \gamma)^2 - 4\alpha\gamma$. A large number of interesting properties, both algebraic and geometric, of such a triple are found. The study is not yet complete.

The Rôle of the Absolute in Geometry. E. A. CAMERON.

The effort to obtain general definitions of metric properties of plane geometrical configurations results in the introduction of an assumed fixed conic called the Absolute by Professor Arthur Cayley. Distance and angular measure are defined in terms of the elements involved and the Absolute. Thus, metric properties of figures are shown to be properties of figures considered in relation to the Absolute conic.

The theory of the Absolute is developed as a natural outgrowth of some elementary projective considerations. Formulas for the distance between two points and the angle between two lines are derived in terms of the coordinates of the elements. The same unit is adopted for both measurements.

One chapter is devoted to a discussion of Cayley's approach to the theory, and his definitions and results are shown to be equivalent to those developed in the previous work.

The nature of the Absolute conic determines the type of metric geometry. It is specified that the Absolute is real, imaginary, and degenerate successively, and the general formulas are shown to reduce to the analytic formulas of Hyperbolic, Elliptic, and Parabolic geometry respectively.

The relation between projective geometry and the several types of metric geometry is demonstrated by means of the theory of the Absolute.

On the Osculating Cubic of a Plane Curve. J. W. LASLEY, JR.

The projective differential geometry theory of plane curves contains the equation of the osculating cubic referred to a local projective reference frame. It contains also a canonical expansion for the original curve referred to a canonical reference frame. This paper calls attention to a simpler equation for the osculating cubic by referring it to the canonical reference frame and by making use of the canonical expansion for the curve. It makes use of this equation and of two different parametric representations of the pencil of penosculating cubics to determine a significant invariant coefficient in the canonical expansion.

H. R. TOTTEN, *Secretary.*

A FOREST POLICY FOR NORTH CAROLINA[1]

By J. S. Holmes, State Forester

At the time of the earliest settlement North Carolina was no doubt entirely covered with virgin forests, the only naturally treeless land being small areas of marsh subject to inundation by salt water.

After a period of 250 years, at the time when slave labor ceased, there was probably more land under cultivation than there is today. The past 70 years has seen much of that cleared land grow up again in forests, seeded in naturally from the old trees which still stood in the surrounding woodland. These second growth forests have now shared the fate of the surrounding original ones, having yielded their merchantable timber to the axe and saw to be subsequently burned and neglected, and, in many cases, practically destroyed.

We seem now to have reached a stage in our development where the balance between agricultural and forest land has reached a fairly stable equilibrium. Out of a total area of 31,193,000 acres, it is estimated that less than 10,000,000 acres are under cultivation and that some 21 million have some kind of forest growth and are of more value for growing trees than for any other purpose. The state's problem is to restore that land to its highest productive capacity and then maintain it in service to the people of North Carolina and the country of which this state is a part.

A study of the ownership of this forest land reveals the fact that some 380,000 acres are included in the national forests, purchased from private owners by the federal government during the past twenty years. There are some 40,000 acres of municipal forests held in connection with city water supplies, and about 100,000 acres belonging to state departments and institutions. All the rest is at present owned by private parties.

It seems then that our problem is how the state can best serve its citizenship in rehabilitating and maintaining at its highest productive capacity this 20 million acres of forest land now in private ownership.

[1] Presidential Address before the North Carolina Academy of Science, May 10, 1929.

How far should the public go in encouraging or requiring the private owner of land to maintain his property in a productive condition? There are not a few public men, Gifford Pinchot among them, who contend that timber production, stream control, wild life protection, and public recreation are of such importance to our progress and well-being as a state and nation that regulation of private forests is not only justified but demanded.

There are those, on the other hand, who maintain that a man can do what he likes with his own, that the state has given him title to his land, that he can therefore burn it, devastate, practically destroy not only its earning power, but its power to yield public revenue, and keep it in such useless condition perpetually.

While I do not share the opinion of the majority that property in land is a sacred and inviolable right and that any attempt to regulate its use is communistic and therefore destructive to the state, there are at present too many difficulties in the way of public regulation and control of private forest land to justify its early adoption as a general policy. It is quite possible that drastic measures may eventually be found necessary to prevent the annihilation of our invaluable timber resources, but for North Carolina I believe there is a better way. The public should acquire a considerable proportion of the forest land, especially that of poorer quality which cannot be profitably carried by the private owner, and administer it for the benefit of all our people. This is to a very large extent the method in use in the older countries of Europe where forestry has been practiced for one or two centuries, while in most of the newer countries nearly all the wild forest land is in public ownership. Even where the land has to be purchased, as it would have to be in North Carolina, purchase programs are going forward rapidly in such countries as New Zealand as well as in many of our sister states. The lands could very properly be paid for with state bonds, maturing as the timber matures and being retired by the sale of the first crop of timber—an excellent investment even in a state where bond issues are not popular.

Forestry Demonstration. Demonstration in forestry practice is a recognized public activity, the Agricultural Extension Service reaching the farmers through one or more trained men while long and short time demonstrations on state-owned land in smaller or larger areas throughout the state furnish experimental as well as demonstrational opportunities in many states. This latter has only just been started in North Carolina and more state-owned forest areas, properly distributed, are needed.

The state should eventually acquire, probably in every county, one or more tracts of better quality forest land to be used as experiment forests or for demonstration as a part of the general state instructional plan. It must also maintain protection forests so that it may share with the federal government and with municipalities the duty of protecting our streams. The government should be encouraged to round out its national forest program, while cities and towns should acquire and care for the catchment basins of their water supplies.

State Parks. In addition to these commercial forests, the state should acquire and administer forest and other wild lands for the primary purpose of recreation. In these days of improved highways, rapid travel, and growing interest in the out-of-doors, it is impossible to separate a state land policy from the recreational use of the woods. State-owned—and usually state-operated—parks, camp sites, beaches, lakes, hunting grounds and game refuges should be scattered throughout North Carolina devoting to each form of use the areas especially adapted to its present and future needs. The National Conference on State Parks (which, by the way, is holding its ninth annual meeting at Clifty Falls State Park, Indiana, this week) a few years ago adopted the slogan "A state park every 100 miles." This has already been exceeded in a number of states and North Carolina now ranks nineteenth in the number of such areas with its Mount Mitchell, Fort Macon, and Rendezvous Mountain Parks.

The people are going to demand an adequate park system, not only for their own pleasure, but to help attract and interest the thousands of tourists who drop dollars wherever their cars stop. We have waterfalls, mountain peaks, gorges, lakes, streams, beaches, forest types, and historic places as beautiful and interesting, and in their own way as deserving of preservation, as those of any state in the Union. Such features are the inalienable heritage of all our citizens and the state should not countenance their destruction by private commercialization.

Tax Relief. In the settlement of our country the better quality land, that most suitable for agriculture, was acquired by the home makers; and this land, much of which is now cleared, together with a considerable proportion of less desirable uncleared forest land, now comprises our nearly 20 million acres classed as farms.

The lumberman (and sometimes the speculator) came along later and purchased land, often for an absurdly small price, simply because that was the easiest way to secure and hold the standing timber which might later be needed in his business. Usually the land was non-agricultural, or what is termed "absolute" forest land.

Now that the original crop of timber has been removed from a large part of this land, and fire and roaming livestock have prevented adequate regeneration, the owners are contending with much truth that they cannot afford to take the steps necessary to return these lands to their original state of natural production because the accumulating costs of interest, taxes, and operation would amount to more than any probable revenue.

These owners of cutover and poorly producing lands, not only in North Carolina, but throughout the United States, are therefore asking to be relieved of at least part of their tax burden, and foresters are advocating a tax especially adapted to a long-time crop, consisting of a small annual tax on the land in proportion to its yielding capacity and a final tax on the timber when cut when the money is available for its payment. Such a tax can be put into general operation only by fair adjustment of other taxes so that the necessary local annual revenue would not fail. One of the main reasons for the passage by the recent legislature of the law to provide for a constitutional amendment allowing the general assembly to "adopt such classification of real property and of personal property as it may find to be reasonable" is that growing, young timber may be relieved of an annual tax.

While such relief would better enable landowners to grow timber at a profit on medium and better quality land, there is much land, no doubt, that would never pay an attractive revenue even though taxes were reduced to a minimum. Those who have experienced the high cost of fire protection or of artificial reforestation, or have suffered from the uncertainties of local assessments or the variations of the markets, fully realize this and they are now ready and anxious to sell such land at low prices. After many years of effort in trying to sell good, bad or indifferent cutover land for farms, such landowners are now seeking a reasonable market. The only way the state can be assured that the more or less inferior lands will be returned to their former condition of usefulness is for the state to hold and administer them again.

Fire Prevention. The statement has frequently been made that fire prevention is 90 per cent of forestry. While I would not attempt to defend that extravagant claim, it is readily admitted that most forestry money is still used for this purpose. This is as it should be, for until some degree of fire control is assured no satisfactory results can be secured from other measures. A good beginning has been made, however, towards reducing the average annual damage by fire in this state of around one million dollars. Our goal is to make protection so effec-

tive that growing timber will become an insurable risk. Up to the present time, protection has been confined to some forty counties which were sufficiently interested in fire prevention to make a more or less adequate appropriation to be used with a similar sum from the state for the suppression of forest fires. It is planned very shortly to extend the work throughout the state, but to carry on only educational and law enforcement work in those counties which do not co-operate. Private land owners take part through loosely organized associations on a contributing basis of from one to five cents per acre. The federal government has suggested that costs of protection be borne equally by the four interested agencies, the federal government, the state, the county and the landowner. When thoroughly organized, an average of one cent per acre for each of these four agencies would cover the cost in this state. Methods and means used to combat fires include lookout towers connected by telephones for detection, wardens and fire crews armed with specialized tools for suppression, investigation followed by prosecution of responsible parties, reports, imspection, etc. The goal of one-half of one per cent of the total forest area burned over annually has been set for attainment in five years time, but when that has been reached no doubt a still better record will be sought.

Insect Control. The control of insects is even more difficult, and just as important, as fire protection. Those who are most conversant with insect damage to forests and their products claim that the money damage done to forests by insects far exceeds that done by fire. One forest entomologist, Dr. J. A. Beal, estimates that an annual drain on our forests of three hundred million dollars is caused by insects. This has been called the age of insects and certain it is that all users of the land, and practically all dwellers on the earth, now have to wage unremitting warfare against this group.

It seems certain that the increase in various species of forest insects is attributable chiefly to unnatural conditions brought about by man; and the only permanent remedy is to restore, so far as is possible in a civilized and growing country, the natural state of the forests. The removal of the timber by clear cutting and the substitution either by natural or artificial means of one species forests, technically known as "pure" forests, for the more stable and resistant mixed forest has no doubt contributed to the present condition. "Nature has many controls at work," again quoting Dr. Beal, "which may be upset by man's activities. An example of man's interference with nature's balance is the reduction of bird life in the forests, for many birds feed entirely on

Figs. 1–6 painted by Alma Holland; figs. 7, 8, by Dorothy Coker

Figs. 1, 2. Hygrophorus Ravenelii. No. 3590.
Fig. 5. Omphalia lilacifolia. No. 3557.
Fig. 7. Tricholoma niveipes var. australis.
Figs. 3, 4. Lentinus Micheneri. No. 3527.
Fig. 6. Prunulus syringeus. No. 3474.
Fig. 8. Hygrophorus luridus. No. 3353.

insects." Bird protection should certainly be one feature of a state forest policy.

Looking into the future with our present knowledge and experience, it seems essential that the vast majority of our rougher and poorer lands, at least, be maintained in producing mixed forests, to be cut, so far as possible, on a selective system. This can be accomplished only through some kind of state regulation or control.

Disease Control. Fungus diseases, as well as insect pests, are much more difficult to control in trees and forests than in farm crops because of the size of the host plant and because of the comparatively low value of the crop; yet the federal and state government co-operating with landowners for years fought the chestnut blight unsuccessfully and are now fighting the white pine blister rust.

Devastating fungus diseases seem to be a product of our civilization, their spread being made possible, or at least greatly facilitated, by modern transportation coupled with unwise practices. The use of native species in natural forest associations, cut conservatively, would have saved much of the trouble and loss we have already experienced.

Erosion. The prevention of soil erosion is an important feature of a state forest policy. More than twenty years ago a member of this Academy made the statement that, "The soil and soluble matter yearly washed in the rivers from the piedmont, North Carolina, with an area of about 12,000,000 acres, certainly amounts to more than 4,000,000 tons, and the plant food in it has a value of more than $2,000,000."

In announcing only last month that "Definite plans for attacking the national soil erosion problem" had been formed by three co-operating branches of the federal government, it was stated by the U. S. Department of Agriculture that the "enormous annual loss of soil and soil fertility from rain wash and gullying is now estimated at approximately $200,000,000."

The Director of the Great Basin Experiment Station recently writing in a technical journal says: "Protection of the soil will have to be accomplished largely by good forestry, the prevention of fire, and the application of proper grazing practices." In other words, a proper distribution of land industries will prevent the destruction of the soil by erosion. In general terms the steeper, rougher surfaces should never be cleared, but be perpetually retained in tree growth; the rolling land and more gentle slopes should be kept in properly regulated permanent pasture; while the level or slightly rolling land least subject to erosion should comprise the bulk of our cultivated land.

The economic advantage of withdrawing agricultural settlement from our rougher forest regions and developing valley communities is beginning to receive attention. The superintendent of education of one of our western counties has recently advocated this as a wise county policy. The reduction of road construction and maintenance, the saving in school transportation, school buildings and personnel; the improvement in markets and in community life; all seem to justify such a move.

Forest Planting. While there is scarcely an acre of natural forest land in the state that would not reforest naturally under proper management, there are vast areas which through careless and indifferent handling during and subsequent to lumbering will not return to a productive condition within a reasonable time unless they are planted. These range from the spruce lands of the high mountains to the pine lands of the coast. It is the state's duty to see that these lands are not left idle or unremunerative.

There are also badly eroded and waste lands on almost every farm which would increase the farmer's revenue if they were growing a crop of timber. In order to assist and encourage the land owner in such forest planting this state has already established one forest nursery for the production and distribution of seedlings to landowners at cost; not with the idea of competing with commercial nurseries, but of supplying suitable trees at a price which will justify planting as a business venture. A second nursery will be started at the first opportunity.

But the value of planting is educational quite as much as it is economic. The experience of establishing and caring for a plantation greatly increases appreciation for all young trees, while the necessity for absolute fire prevention makes every tree planter a foe to forest fire. A forest nursery established on a well travelled highway is a state's best lecturer on forestry.

Forest Management. The State in administering its own forest lands can put into practice those measures which seem best suited to the kind of forest and the growth and market conditions in each separate instance. Private owners, however, must be convinced that it will pay before spending any appreciable amount of money on improvements that bring in no immediate returns. Probably the most promising method of cutting pine or other "pure" forest is with a diameter limit, leaving all thrifty trees below a certain diameter. In this way the quality of the cut is improved and the cost of cutting reduced, while enough young trees are left to occupy the growing space and yield another cutting in fifteen to twenty-five years.

The selection system, by which mature individuals are cut without injuring the quality of the forest, seems best adapted to the mixed forest. At present very few lumbermen approach these ideal methods, but landowners who are interested in perpetuating the forest exhibit a growing interest in better forest management.

The prevention of waste in the woods and at the mill is largely governed by transportation and markets. However, over-production is probably the most fertile and inexcusable source of waste. The utilization of waste can sometimes be brought about by studying both supply and demand of this waste material and establishing consuming industries. Such a study has recently been made in North Carolina.

Education. Burning the woods, indiscriminate cutting, carelessness and indifference have been the habit of our people so long that a widespread conversion must be brought about before permanent results can be obtained. The general public must be reached in every possible way so that "forest mindedness" will replace indifference in the attitude of our people. Children can be interested in the schools by contests, lectures and books coördinating forestry with required studies. Much can be gained by reaching the teachers through summer schools. Adults are harder to reach with publicity so demonstration should be added.

The State Agricultural Extension Service is now showing the farm woodland owner how to thin, cut, estimate and improve his timber crop through demonstration. Every member of the State Forest Service must remember that he is a missionary and that as such no opportunity must be overlooked.

Summary. A Forest Policy for North Carolina must be based on the principal of putting all the land to its best and highest long-time use. The present status of forest land ownership is unstable because much land is not yielding, and probably cannot yield, a satisfactory profit to its owners. A large extension of public ownership is therefore necessary. State-owned demonstration and experiment forests are greatly needed. A system of attractive state parks will bring tourists to the state and perpetuate our scenic resources.

The relief of the growing timber crop from annual taxation and the substitution of a yield tax seem advisable, but a fair adjustment to provide local revenue must be worked out.

Forest fire prevention participated in by all interests is the first essential in better forest management.

Insect and fungus control are second only in importance to fire and

methods of control are even more difficult. A return to mixed forests seems desirable.

The prevention of erosion is one of the important functions of the forest.

The distribution of forest trees from a state nursery for planting not only encourages reforestation, but stimulates interest in fire prevention and natural regeneration.

Better forest management on both state and private land will depend not only on markets, but on the results which may be achieved through all forms of education to bring about "forest mindedness" on the part of the public.

POLLEN ANALYSIS OF DISMAL SWAMP PEAT

By Ivey F. Lewis and E. C. Cocke

Plates 3–5

It is the purpose of this paper, by using the method of pollen analysis, to trace the history of the vegetation of a small area of the Dismal Swamp of Virginia and North Carolina.

As a result of the investigation of Von Post (18), who was a pioneer in the study of glacial bogs from this standpoint, and others who followed him, European bogs have been studied extensively. Little has yet been published on American bogs, and nothing on bogs of the great area south of the glacial ice. The work of Väinö Auer (12) on bogs along the St. Lawrence River is up to the present time the most important paper in which the method of pollen analysis is applied to American bogs.

Grateful acknowledgements are made to Dr. E. M. Betts and Professor W. A. Nelson of the University of Virginia, Dr. P. B. Sears of the University of Oklahoma, Mr. Paul W. Bowman of George Washington University, Drs. Neil E. Stevens and C. L. Shear of the Bureau of Plant Industry, the Virginia Forestry Department, and especially to Professor Alfred Akerman for valuable assistance.

Topography

According to Shaler (15, p. 313), "The Dismal Swamp is the northernmost part of the characteristic swamp country which borders the Southern Atlantic Coast. It belongs altogether to that group of inundated lands where the lack of drainage is due to an original deficiency of slope, combined with the flow-retarding influence of vegetation on the movement of water from the land." The Dismal Swamp according to Shaler's classification must be considered as a precipitation swamp, since the level of the water is considerably lowered in summer and raised in winter.

"Although swamps of a similar character are imperfectly developed in the region north of the Potomac, they do not take on a conspicuous aspect until we pass southward of that stream; and this for the reason

that the surface of the country north of it is considerably higher than in Southern Virginia and North Carolina, and has developed a stronger topography" (Shaler, p. 313).

The Dismal Swamp district includes that territory lying between the James River and Albemarle Sound and east of the Nansemond escarpment. Shaler estimates this area at about two thousand two hundred square miles, of which seven hundred square miles have been drained. A considerably larger amount of the inundated land has been drained since the publication of Shaler's paper (1890). The total swamp lands at present probably do not exceed seven hundred square miles.

The peat deposits of the swamp are underlain by the old sea bottom, which is of Pliocene age. Shaler makes the following statements in regard to the formation of the swamp: " . . . . we find that on the west, in the Dismal Swamp district, this billowy plain is sharply bounded by an escarpment formed by the sea when the surface of the continent was about twenty-eight feet below its present level. . . . . .

"The eastern boundary of the swamp district is determined by certain elevations, apparently dunelike in their nature—extending from Norfolk to Elizabeth City. This latter system of elevations, which attain a height of only a few feet, serve in a measure to retain the swamp waters upon the surface on which they lie. They are, however, of relatively small importance compared with the effect produced by the vegetation of this district" (p. 314).

The surface of the swamp is convex, presenting the general appearance of an inverted saucer. The highest point is Lake Drummond, north of the center of the swamp. Here the elevation is 22.5 feet. The swamp slopes gradually toward the eastern and southern margins, where it approaches sea level.

This general appearance of the surface of the swamp is identical with the condition which Nichols (10) describes as typical of a raised bog. The history of the vegetation, on the other hand, is contrary to that of this type of bog.

The thickness of the peat varies from three to seventeen feet. In taking samples for this study, however, the maximum depth found was twelve feet. Samples reported on in this study were taken east of U. S. Highway No. 17 which parallels the Dismal Swamp Canal, and from ½ to 1 mile north of Wallaceton. The work is being continued on samples taken elsewhere in the swamp and around Lake Drummond.

There is agreement among geologists that this swamp is postglacial. Shaler has noted four distinct fluctuations in levels of this area since the

time of the great Ice Sheet. These changes of level if they occurred during the deposition of peat, must have had a profound effect on the vegetation.

CLIMATE AND VEGETATION

Kearney (7) gives sufficient data as to present climatic conditions and existing vegetation to make it unnecessary to repeat details concerning these subjects. It may be mentioned, however, that the Dismal Swamp area is the northward continuation of the lower Austral or Austro-Riparian life zone. Many of the characteristic plants of this zone are found in the Swamp and some reach their northern limit here.

METHODS

In taking samples for this work a peat borer of the Davis type was used. Cylindrical cores of peat, about six inches long, were removed at different levels from the surface to the underlying sand, and placed in bacteriological shipping containers. In order to prevent mixing of samples from different depths, a new hole was bored for each sample taken.

Four borings were made near Wallaceton, in all of which the peat was found to lie on a blue clay mixed with sand. The thickness of the peat at Wallace's Store and at a point 500 yards south was ten feet. Five hundred yards north of Wallace's Store the thickness of the peat was only three feet, but 500 yards farther north there was a thickness of 12 feet.

For microscopic study permanent slides were made in the following manner. The peat was boiled about two minutes in 10 per cent potassium hydroxide and then strained to remove the coarser particles. The fluid containing the pollen grains and other small particles of detritus was boiled about 10 minutes in KOH and again strained through several thicknesses of cheese cloth.

After using the centrifuge and decanting, the pollen was washed in several changes of water, then carried through alcohol and xylene to be finally mounted in damar. Safranin proved to be a satisfactory stain, giving the desired opaqueness and bringing out characteristic markings and pores of the pollen. Slides made in this way show comparatively little trash and a large number, as many as 3000, pollen grains on each slide. At least 12 slides were made from each sample taken.

As most of the work done on peat bogs has been done in Europe, it was difficult to secure a good pollen key for identifying the fossil grains

found. Edgeworth's book (4) on pollen has many well executed plates but the explanation is not clear and definite. Edgeworth was not interested in fossil pollen and consequently his plates were of little value in determining such grains. Scheppegrell's book (14) has several photographs which were helpful, especially those of the Compositae. The best and most useful key found was that of Meinke (8), which is a key of fossil pollen of wind-blown plants of Germany. This key, although good, lacks several very important American species and is in some respects misleading. Erdtman's key to microfossils (5) was not available. Docturovsky and Kudryachov (3) have a useful key with plates illustrating European trees. The careful work of Wodehouse (19) does not cover the species most important in this study.

To supplement the keys and act as a check on identifications, many slides of fresh pollen were made. Since fresh pollen in some cases differs markedly from the same pollen in peat, it was desirable to treat it so as to make it appear as fossil. This artificial fossilization was done by extracting with ether followed by boiling in caustic potash. Such slides are of the utmost value in identifying important American species.

In counting the different pollens for reckoning the percentage of any given species, eight hundred grains were counted from each depth. The counts were made at random over a number of slides from the same depth, but different borings. Whenever any count was made, every grain in that particular field was counted. There were found at each depth a number of grains which could not be identified. These were counted and placed in the list as "unknown." In this way the percentage represents percentage of total pollen.

Analysis of Pollens

It is often impossible to name specifically a pollen grain, but the family and usually the genus can be determined. The considerable number of unidentifiable grains is due partly to insufficient knowledge and partly to fragmentation or deformation of the grains, either during fossilization or during preparation of the slides.

Unbroken grains which were not identified were probably from herbs, shrubs and woody vines. While for a complete account these must be identified, nevertheless the general aspect of the vegetation is adequately given and the trend of succession is indicated by the information here set forth as to the trees and the common lesser constituents of the flora.

The group of disfigured grains very probably contains all types of

pollen. Some pollen is much more fragile than other. This fact is borne out by results obtained in the laboratory in handling certain pollens. The pollens of *Chamaecyparis* (white cedar) and *Taxodium* (bald cypress) were found to be quite delicate. The walls were thin and the grains collapsed and even broke to pieces very easily. It was difficult to prepare even from fresh pollen of these species slides showing any perfect grains, while other pollen treated in the same way made perfect mounts. The fragility of the grains mentioned may account for the small percentage of *Chamaecyparis* found at the surface. Its absence at all other depths and the total absence of *Taxodium*, therefore, may be apparent rather than real.

The sedges, which are easily identified as such, (figs. 17, 18) could not be separated. The same is true of the grasses. The large spherical grains with one pore (figs. 15, 16) are easy to place in the grass family, but only a pollen expert would dare even to guess at the specific or even the generic name of all the grass pollen found.

The Compositae make up another large group in which there is a very characteristic spiny grain (figs. 34, 35), but to identify them generically would be a long, tedious and difficult task.

All of the fungus spores have very thick walls. This fact, along with their shape, makes them fairly easy to place. Some of the spores are shaped in outline like a pumpkin seed (fig. 36), others are more ellipsoid (fig. 39), while still others are seriate. It is not uncommon to find them in rows of three to eight (figs. 37, 38, 40). Concerning these Dr. C. L. Shear of the U. S. Bureau of Plant Industry writes that "the spores could scarcely be identified as to genera, it is also very difficult if not impossible to say with certainty whether they represent spores of Ascomycetes or Fungi Imperfecti, as in many cases very similar spores occur in these groups. I should be inclined to the opinion that the dark colored septate spores are more likely to be those of Hyphomycetes rather than Ascomycetes, as under present conditions such spores are much more abundant and widely distributed."

The willow and oak pollen have the same general shape, but the oak grains are usually larger and less reticulate than those of willow (fig. 24, oak, fig. 19, willow). It is probable that the willow pollen found represents at least two species. The oak pollen represents two or three species. The percentages given in the table for these two genera may require modification and correction after further critical comparisons of the pollen of various species.

The black gum pollen was identified by comparing it with fresh pollen

of *Nyssa sylvatica*, artificially fossilized (see page 40). Some of the fossil pollen was identical in every respect with the grains in the fresh mounts. Other black gums may have similar pollens, however, and perhaps are included in the count of *Nyssa*. Certainly one other species is present having a smaller grain than *N. sylvatica* (figs. 29–32).

The pollens of *Betula* and *Myrica* are much alike, though they may be distinguished with certainty in well preserved specimens (figs. 20, 22).

The maple found compares favorably with the fresh pollen of *Acer rubrum* (fig. 28).

The pollen of *Liquidambar* is unique. In the fresh condition it is not distinctive, but after "artificial fossilization" (p. 40) it is characterized by the presence of about eighteen large round pores uniformly distributed. These pores, while obvious and distinct, are not so clean cut as those of the herb pollen mentioned below.

Several species of moss were found, most of them belonging to the Bryales. *Sphagnum* was present in very small amounts. The spores of *Sphagnum* are well and easily identified (figs. 1, 2, Bryales; 3, *Sphagnum*).

The Pteridophytes identified were divided into three classes, polypods, *Osmunda* and *Lycopodium*. The polypods are of two types; the swamp type represented by *Woodwardia* (fig. 11), now so abundant in open areas, and the forest type represented by *Asplenium* (fig. 9) and *Aspidium* (fig. 8). Records of the polypods at the lower levels are mostly *Woodwardia*, at the upper levels the forest type is dominant.

Lycopodium occurs in patches. The spores do not blow far, so that a sample from one spot may not be representative of the entire region. The appearance and disappearance, which will be noticed in the following section of this paper, may be due to these conditions.

Ericads, *Gelsemium*, *Nymphaea*, and *Polygonum* are insect pollinated. The repeated occurrence of their pollens at different levels indicates their presence in some abundance. Percentage statements, however, are not comparable in the cases of entomophilous and anemophilous flowers, because in the former less pollen is produced, more of it is destroyed and it is not uniformly distributed. Similar considerations apply to the Compositae, *Ilex*, and perhaps others. In general a positive record of entomophilous pollen indicates greater abundance than the same percentage from anemophilous flowers. Wind blown pollen may be expected to be distributed at random, while pollen carried by insects will not be evenly distributed, but will get into the soil usually where the flowers themselves decay, that is in the immediate vicinity of the plant concerned.

In the tables given below, Compositae, because of their characteristic grains, are easily distinguished as such. A considerable number of other herbs may be distinguished as belonging mostly to Chenopodiaceae and related families. These are characterized by having a varied number (14–100) of "holes cut sharply into the exine" (Wodehouse, 19, p. 150). "Herbs" indicates, then, in the tables, herbs other than Compositae.

TABLE I

TEN FOOT LEVEL

TYPE OF POLLEN	PER CENT
Gramineae	27.5
Cyperaceae	23.75
Pinus	8.75
Osmunda	6.0
Polygonum	3.75
Salix	3.75
Herbs	0.37
Fungi	0.25
Unknown	25.88

In view of the well-known activities of earthworms in carrying soil up and down, it should be mentioned that no traces of earthworms have been found in the peat at any place in the swamp.

Although the peat extends in some places to a depth greater than ten feet, in taking samples for this work only one boring exceeded that depth. This single boring went two feet deeper, but the lowest peat was mixed with a large amount of sand, and only a very few plant forms could be distinguished, mostly diatoms, which will be reported on later. Analysis of the borings begins at the ten foot level, where the pioneer vegetation was beginning the deposition of plant detritus.

It must be remembered that the data and conclusions given here apply only to one area in the large unit known as the Great Dismal Swamp. There are no grounds for concluding, without further study, that the picture of vegetational succession applies elsewhere than to a restricted region near Wallaceton, about four miles east of Lake Drummond.

The high percentage of grasses and sedges, the total of which make up more than one-half of all pollen found, indicates that an open meadow was the vegetation type. Under the climatic conditions (moderate

temperature and heavy rainfall) and considering also the edaphic factor, indications point to the marsh type of vegetation in general. It is known, however, that the floor of the Dismal Swamp was a rolling plain on which the hills were at least 14 feet higher than the depressions. Trees found, such as *Salix* and *Pinus*, probably occupied the higher levels, though it is possible that the comparatively small amount of pine pollen was blown in from the neighboring forest.

TABLE II

NINE FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Pinus	18.88	+10.13
Cyperaceae	12.5	−11.25
Gramineae	10.0	−17.5
Salix	7.5	+3.75
Osmunda	6.0	
Polygonum	4.37	−0.62
Castalia	4.0	New
Polypodiaceae	3.5	New
Compositae	2.5	New
Herbs	1.87	+1.5
Asimina	1.5	New
Lycopodium	1.0	New
Ericaceae	0.75	New
Liquidambar	0.63	New
Carya	0.62	New
Nyssa	0.5	New
Unknown	24.5	−1.38

Table II indicates that the swamp has become a fresh water savannah. The appearance of water lily, club mosses, pawpaw, heaths, hickory, sweet gum and black gum, and an increase in willow, give positive proof of this. The great increase in pine indicates that all of the pine pollen was not blown in at this depth, but that pine was actually growing in the swamp at this time. The presence of the other trees listed would indicate that the conditions were suitable for the growth of pine which is usually a pioneer tree. Other trees are not present in sufficiently large quantities to choke out pine as they later do.

The increase in woody plants from 12.5% to 29.63%, with a corresponding decrease of grasses and sedges from 51% to 22.5% shows a fresh water substratum and a much richer vegetation, with an increase

in wooded areas and a decrease in open spaces. The occurrence of hickory and pawpaw at this level is unexpected, since they are by no means pioneer types, but the general picture presented is such that the beginnings of a permanent forest type of vegetation seem to have been made. Hickory does not occur in the swamp though it is a common tree in the regions adjacent, while pawpaw is reported as occurring near Lake Drummond (Kearney, 7, p. 526). *Liquidambar* is now a common tree in the swamp.

The occurrence for the first time of Polypodiaceae, Compositae, and *Lycopodium* and the increase in herbs are consistent with the rest of the picture.

TABLE III

EIGHT FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Gramineae	19.25	+9.25
Cyperaceae	15.0	+2.5
Pinus	9.75	−9.13
Fungi	9.62	+9.62
Polypodiaceae	8.25	+4.75
Castalia	4.75	+0.25
Salix	3.75	−3.75
Liquidambar	2.50	+1.87
Osmunda	2.5	−3.5
Typha	2.25	New
Polygonum	2.12	−2.25
Herbs	1.5	−0.27
Alnus	1.25	New
Nyssa	1.25	+0.75
Compositae	1.0	−1.5
Lycopodium	0.87	−0.13
Carya	0.25	−0.37
Quercus	0.12	New
Ilex	0.12	New
Unknown	15.37	−9.12

At the eight foot level the natural line of development seems to be upset. The grasses and sedges become more abundant while the trees and shrubs show a marked decrease. Fungus spores, which were not found at nine feet, make up 8.62% of the total. These are evidently not the cause of the retrogression, however, since at the six foot level

progressive factors are conspicuously indicated, yet the fungus spores are as abundant as ever.

The constitution of the flora indicates a gradual drying, with the appearance of *Quercus* and *Ilex*. This drying is followed by a general diminution of vegetation and the disappearance of certain genera, retrogressive changes which are fully shown at the next level. Pine and willow show a great decrease at eight feet as compared with the figures at nine feet, the former from 18.88 to 9.75%, the latter from 7.5 to 3.75%. *Liquidambar*, however, shows a considerable increase.

TABLE IV

SEVEN FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Gramineae	22.5	+3.25
Fungi	15.0	+6.38
Polypodiaceae	11.5	+3.25
Salix	10.5	+6.25
Cyperaceae	10.0	−5.0
Pinus	5.0	−4.74
Castalia	2.25	−2.0
Liquidambar	1.00	−1.50
Compositae	0.75	−0.25
Herbs	0.5	−1.00
Nyssa	0.25	−1.0
Unknown	20.75	+5.38
Carya	0	−0.25
Ilex	0	−0.12
Lycopodium	0	−0.87
Alnus	0	−1.25
Osmunda	0	−2.5
Polygonum	0	−2.12
Quercus	0	−0.12
Typha	0	−2.25

At this level certain astonishing changes which are retrogressive are shown. The most noticeable is the disappearance of many important genera which had begun to flourish at nine and eight feet. Another striking thing is the increase of willow, grasses, polypods and fungi, with a general decrease elsewhere.

It is evident that something checked the development of the vegetation at the eight foot level. At seven feet the results of this retrogression are conspicuously indicated. The nature of the change leading to the

extinction of four out of the seven genera of trees (*Carya, Ilex, Alnus, Quercus*) and of four other well marked genera (*Lycopodium, Osmunda, Polygonum, Typha*) cannot be stated with finality. The possibility suggests itself that there occurred at about the eight foot level one of the oscillations of the land level referred to by Shaler (15, pp. 328–332). With the sinking of the land, much of the existing vegetation was drowned out by the increasing wetness of the substratum. That the accumulating water was fresh is indicated by the fact that the *Typha*

TABLE V

SIX FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Gramineae	15.0	−7.25
Fungi	15.0	
Cyperaceae	11.25	+1.25
Salix	10.0	−0.5
Polypodiaceae	8.12	−3.37
Pinus	6.25	+1.25
Polygonum	2.25	*+2.25
Liquidambar	2.17	+1.17
Osmunda	1.87	*+1.87
Nyssa	1.25	+1.0
Bryales	1.25	New
Quercus	1.12	*+1.12
Typha	0.88	*+0.88
Castalia	0.63	−1.62
Herbs	0.60	+0.1
Gelsemium	0.25	New
Carya	0.25	*+0.25
Unknown	21.86	+1.11

* Return.

species here recorded is *T. latifolia*, which is characteristic of fresh water pools and swamps. *Typha angustifolia*, the brackish water type, is nowhere found in our collections.

The rapid recovery from the condition of depression seen at the six foot level lends support to the hypothesis that the unfavorable factors were of short duration. That the effect of these unfavorable factors was severe is shown, (1) by the extinction of certain trees and great diminution of others (*Pinus, Liquidambar* and *Nyssa*), only *Salix* retaining its position; (2) by increase of fungus spores (see page 41) to

the surprising amount of 15% of all spores found; and (3) to the decrease in number of named genera or families from 18 at the eight foot level to only 10 at seven feet.

At six feet the normal condition of vegetation returns. The grasses and sedges decrease considerably and the forest types increase. Five genera return. These are *Polygonum, Osmunda, Quercus, Typha,* and *Carya.* Two types which are common in forest areas appear for the first time—*Bryales* and *Gelsemium.* Fungus spores are present in large numbers, but in spite of this the development is proceeding normally toward the climax type.

The return of *Typha* indicates wet substratum. Other conditions show that the forest is establishing itself, and that open spaces are decreasing.

TABLE VI

FIVE FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Pinus	15.0	+8.75
Salix	12.5	+2.5
Gramineae	10.62	−4.38
Cyperaceae	10.0	−1.25
Liquidambar	5.63	+3.46
Herbs	7.5	+4.38
Polypodiaceae	4.38	−3.74
Carya	4.0	+3.75
Quercus	2.5	+1.37
Fungi	2.5	−12.5
Castalia	2.5	+1.87
Nyssa	2.12	+0.87
Polygonum	1.88	−0.37
Herbs	1.87	+1.27
Bryales	1.62	+0.37
Compositae	1.5	*+1.5
Alnus	1.0	*+1.0
Osmunda	0.5	−1.37
Sphagnum	0.38	New
Myrica	0.25	New
Unknown	19.1	−2.76

* Return.

The great increase in pine, willow, herbs, hickory, oak, sweet gum, and black gum, the reappearance of *Alnus,* and the appearance of

Myrica, together with a marked decrease in grasses, sedges and polypods, show progressive growth of the forest type, encroaching further upon open areas. There is a more healthy condition of vegetation in the swamp at this time than has previously existed, as is shown by the decrease of fungus spores from 15% to 2.5%.

The most interesting thing noticed at this level is the appearance of *Sphagnum*, which has been absent below the five foot level. *Sphagnum*, therefore, cannot be responsible for the upbuilding of the peat level, and has probably always been secondary and unimportant, just as it is at the present time.

TABLE VII

FOUR FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Pinus	13.75	−1.25
Gramineae	12.5	+1.88
Polypodiaceae	9.75	+4.37
Cyperaceae	8.75	−1.25
Salix	8.12	−4.38
Nyssa	5.0	+2.88
Castalia	5.0	+2.5
Carya	3.0	−1.0
Bryales	2.5	+0.88
Herbs	2.08	+0.21
Alnus	2.0	+1.0
Compositae	1.88	+0.38
Lycopodium	1.62	*+1.62
Liquidambar	1.04	−4.59
Quercus	0.63	−1.87
Osmunda	0.62	+0.12
Typha	0.38	*+0.38
Fungi	0.25	−2.25
Gelsemium	0.25	*+0.25
Myrica	0.12	−0.13
Unknowns	20.75	+1.65

* Return.

The decrease in percentage of pine, willow, sweet gum, hickory and oak, and the increase in grass indicate a slight retrogression. The decrease in *Salix* and sedges and the return of *Lycopodium* and *Gelsemium* show, however, a constructive counterbalancing change. The percentage of

fungus spores has now fallen from the high figure shown at six feet to what may be regarded as their normal incidence.

TABLE VIII

THREE FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Salix	11.9	+3.78
Gramineae	10.2	−2.5
Pinus	10.0	−3.75
Nyssa	9.12	+4.12
Cyperaceae	6.38	−2.37
Polypodiaceae	6.25	−3.50
Compositae	5.75	+3.87
Liquidambar	4.40	+3.36
Carya	3.0	
Quercus	2.37	+1.74
Herbs	2.20	+0.12
Alnus	1.88	−0.12
Bryales	1.75	−0.75
Myrica	0.95	+0.83
Osmunda	0.75	+0.13
Castalia	0.62	−4.38
Ericaceae	0.63	*+0.63
Typha	0.5	+0.12
Betula	0.3	New
Polygonum	0.25	*+0.25
Pycopodium	0.25	−1.37
Sphagnum	0.12	*+0.12
Unknowns	20.8	+0.05

* Return.

The increase in willow, black gum, herbs, Compositae, oak, sweet gum and *Myrica*, and the appearance of birch, point toward a forest type of vegetation in the Swamp. This conclusion is borne out by the decrease in grass, sedges and polypods. An indication of a drier and more mesophytic condition, resulting in a closed forest, is the diminution of *Alnus* and *Castalia*. The decrease in pine points toward the climax type of forest under edaphic condition prevailing, as is further shown by the steady increase in black gum and sweet gum, both climax forms.

At the two foot level is seen a continuation of the steady progress toward the climax forest, a closed type of vegetaiion. The decrease in grasses and great decrease in sedges is consistent with the steady in-

crease in various trees, especially black gum, hickory, willow, and birch, and the smaller increase in heaths, *Myrica*, and oak. The absence of *Lycopodium* is another example of its irregular behavior at different levels (see page 42). The disappearance of *Typha* and the decrease of *Osmunda* and *Castalia* point also to increasing dryness.

Black gum is abundant at one foot, willow having decreased greatly. The appearance of maple indicates an approach to optimum conditions.

TABLE IX

TWO FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Salix	15.62	+3.72
Nyssa	12.5	+3.38
Pinus	10.62	+0.62
Gramineae	7.5	−2.7
Polypodiaceae	4.62	−1.63
Compositae	4.5	−1.25
Carya	4.38	+1.38
Quercus	2.5	+0.13
Liquidambar	2.25	−2.15
Herbs	2.25	+0.05
Alnus	1.87	
Myrica	1.5	+0.55
Cyperaceae	1.38	−5.0
Ericaceae	1.25	+0.62
Betula	1.0	+0.7
Bryales	0.63	−1.12
Sphagnum	0.62	+0.5
Typha	0.5	
Polygonum	0.5	+0.25
Osmunda	1.38	−0.37
Castalia	0.25	−0.37
Unknowns	22.5	+1.7

Pine is now stabilized as a small fraction, probably widely scattered as at present. The return of lycopods in large numbers and the increase of polypods (here of the *Asplenium* type characteristic of moist deciduous forests) confirms the conclusion as to the established conditions of the forest, as does the continued abundance of heaths, which form much of the undergrowth at the present time. The return of *Ilex* after a long absence is noteworthy. Sedges and grasses continue their long decline.

Birch has become extinct, while hickory, also not now growing in the Swamp, indicates by a sharp decline its approaching extinction.

The last great change in the development of vegetation of the Swamp is now in progress. This is shown by the great decrease in black gum, accompanied by the appearance in considerable quantity of white cedar. That the transformation is not yet complete is shown by the large number of herbs and composites still present and by the strongly repre-

TABLE X

ONE FOOT LEVEL

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Nyssa	40.62	+28.12
Pinus	10.0	−0.62
Polypodiaceae	9.38	+4.76
Lycopodium	5.0	*+5.0
Gramineae	2.5	−5.0
Compositae	1.88	−3.62
Carya	1.87	−2.51
Acer	1.25	New
Castalia	1.25	+1.0
Sphagnum	1.25	+0.63
Salix	1.25	−14.38
Ericaceae	1.25	
Quercus	1.25	−1.25
Liquidambar	0.83	−1.42
Cyperaceae	0.75	−0.63
Alnus	0.75	−1.12
Bryales	0.7	+0.07
Typha	0.5	
Myrica	0.5	−1.0
Herbs	0.44	−1.81
Ilex	0.38	*+0.38
Unknown	16.25	−6.0

* Return.

sented oaks, heaths, and *Myrica*. The final forest stage of this region seems to be shown by those areas in which white cedar covers the ground in the so-called "juniper glades" or in "mixture with red maples, sour gum, cypress, and sweet gum in what is known as gum swamps" (Akerman 1, p. 5).

The influence of clearing on the surface deposits is seen in the decrease of black gum, greater probably than would be accounted for by the

increasing competition from white cedar and maple; the great increase of herbs and composites, which indicates the occurrence of open areas cleared either naturally or by cutting of the forest trees.

TABLE XI

SURFACE TO EIGHT INCHES

TYPE OF POLLEN	PER CENT	+ GAIN − LOSS
Nyssa	29.5	−11.12
Pinus	11.5	+1.5
Chamaecyparis	6.0	New
Compositae	5.7	+3.82
Polypodiaceae	5.6	−3.78
Liquidambar	4.26	+3.43
Salix	2.5	+1.25
Quercus	2.5	+1.25
Herbs	2.13	+1.69
Ericaceae	2.0	+0.75
Sphagnum	2.0	+0.75
Myrica	1.7	+1.2
Gramineae	1.5	−1.0
Acer	1.25	
Bryales	0.8	+0.10
Alnus	0.8	+0.05
Carya	0.6	−1.27
Polygonum	0.6	*+0.6
Ilex	0.5	+0.12
Typha	0.5	
Cyperaceae	0.5	−0.25
Osmunda	0.4	*+0.4
Lycopodium	0.4	−4.6
Castalia	0.3	−0.95
Unknown	16.7	+0.45

* Return.

SUMMARY

The history of the vegetation at one point in the Dismal Swamp shows a steady development from an open marsh covered with grasses and sedges to a closed forest of black gum, white cedar, sweet gum, and other trees. This gradual development was interrupted at the eight foot level by a disturbance which killed much of the arboreal vegetation and which is best shown by the percentages of pollen from the seven foot level. A second relatively unfavorable period is shown at the four foot level, but this is much less important than the first.

The climax forest, dominated by black gum, is shown at a depth of one foot. Conditions from the surface to eight inches show the appearance of other trees characteristic of the climax forest of this region, complicated by artificial clearing which began over a hundred years ago.

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CHARTS 1–4

Pollen curves reckoned in percentages of total pollen at depths from 10 feet to the surface.

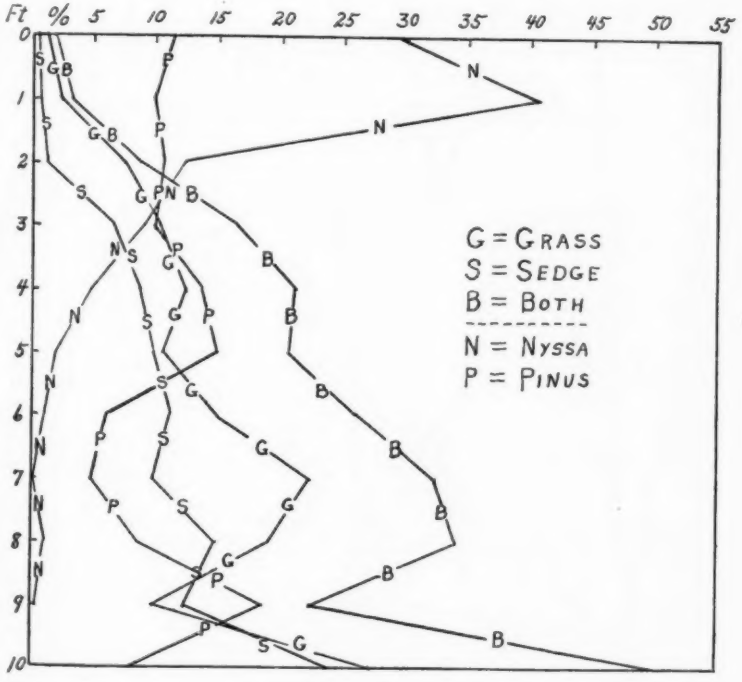

CHART 1

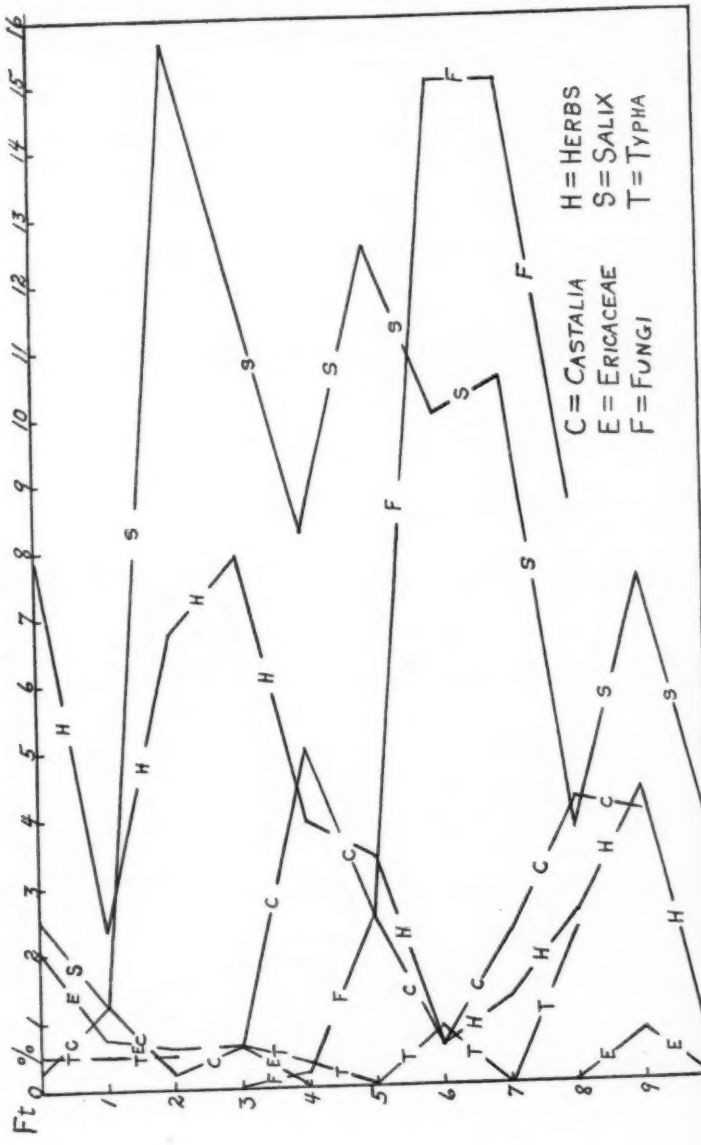

CHART 2

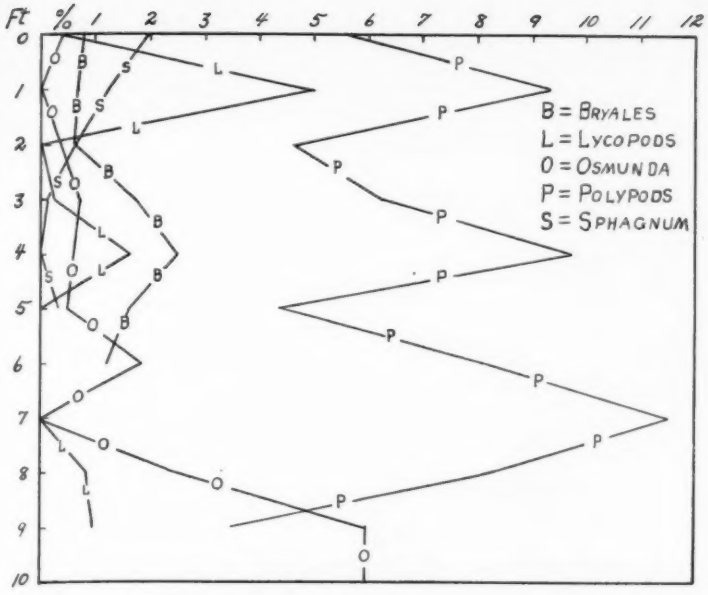

Chart 3

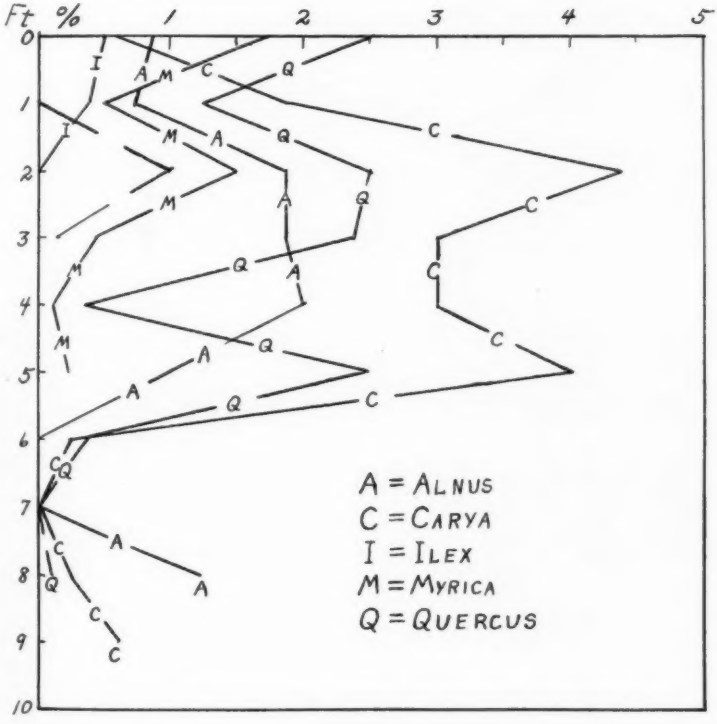

Chart 4

EXPLANATION OF PLATES 3–5

Magnification ×850. All figures from fossil pollen, except 15, 17, 34, which are from fresh material

1. Bryales
2. Bryales
3. Sphagnum
4. Lycopodium
5. Lycopodium
6. Lycopodium
7. Osmunda
8. Aspidium
9. Asplenium
10. Polypodium
11. Woodwardia
12. Pinus
13. Chamaecyparis
14. Typha
*15. Spartina breviligulata
16. Gramineae
*17. Scirpus americanus
18. Cyperaceae
19. Salix
20. Myrica
21. Carya
22. Betula
23. Alnus
24. Quercus
25. Polygonum
26. Castalia
27. Ilex
28. Acer
29. Nyssa
30. Nyssa
31. Nyssa
32. Nyssa
33. Ericaceae
*34. Erigeron pulchellus
35. Compositae
36. Fungus spore
37. Fungus spore
38. Fungus spore
39. Fungus spore
40. Fungus spore

PLATE 3

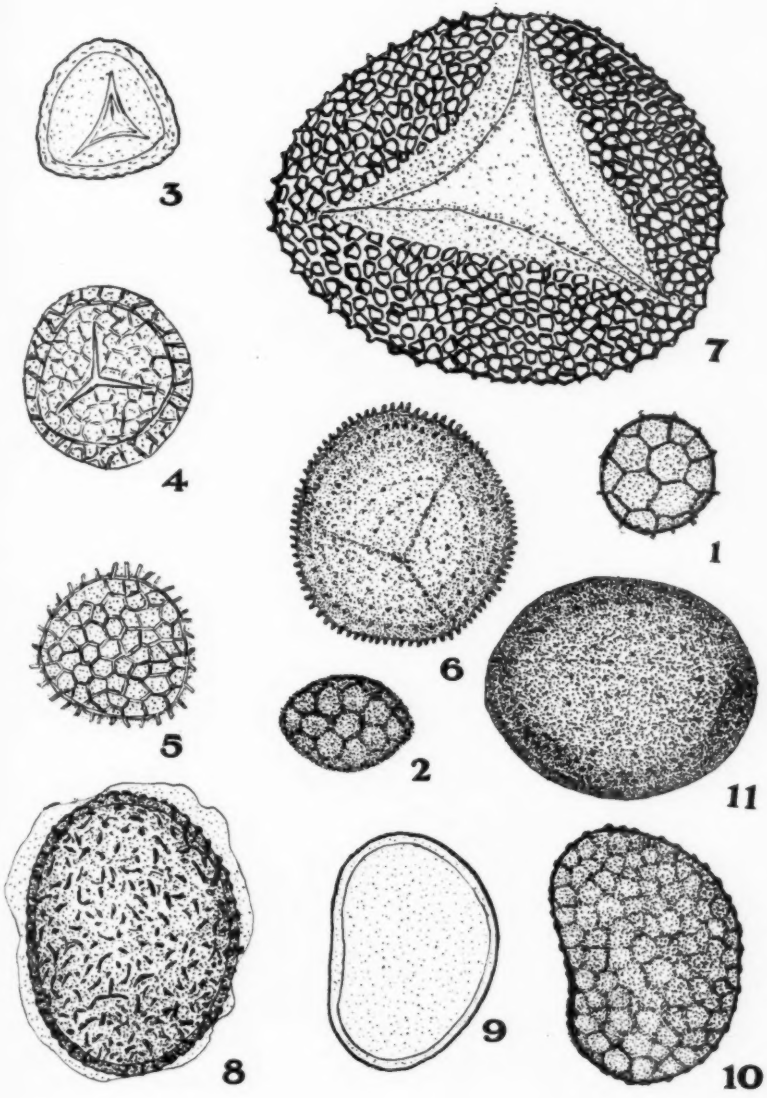

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PLATE 4

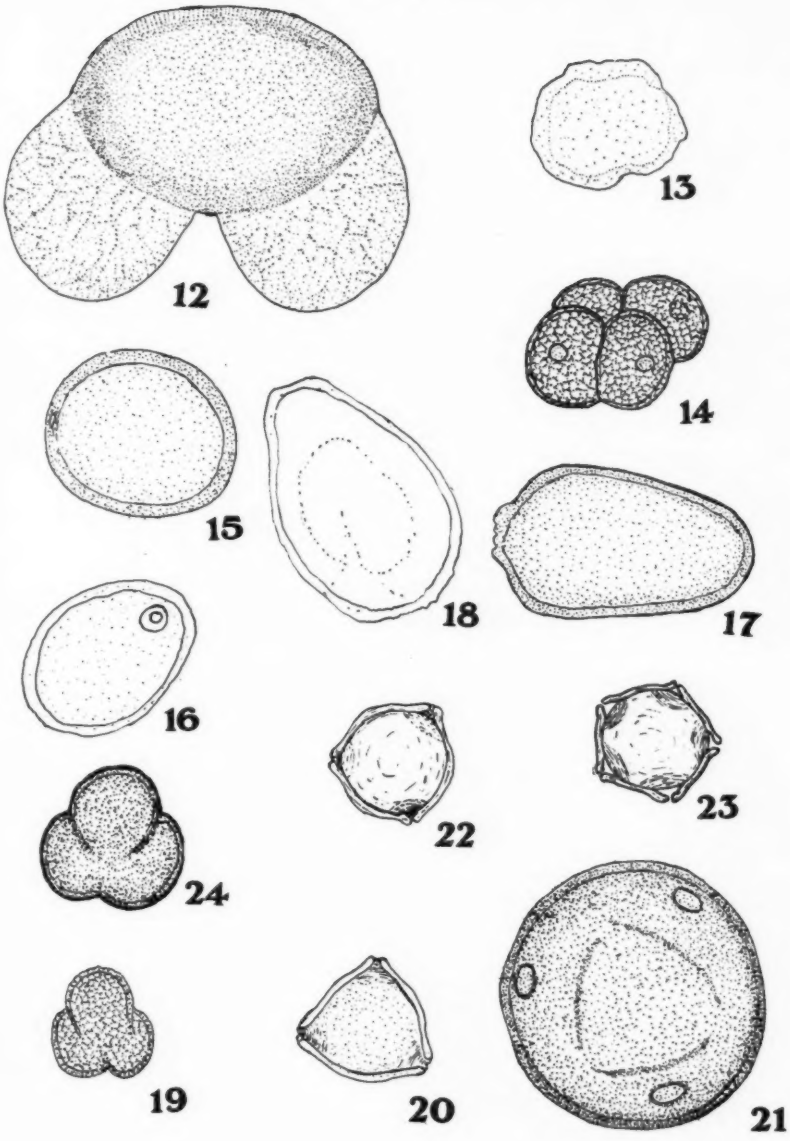

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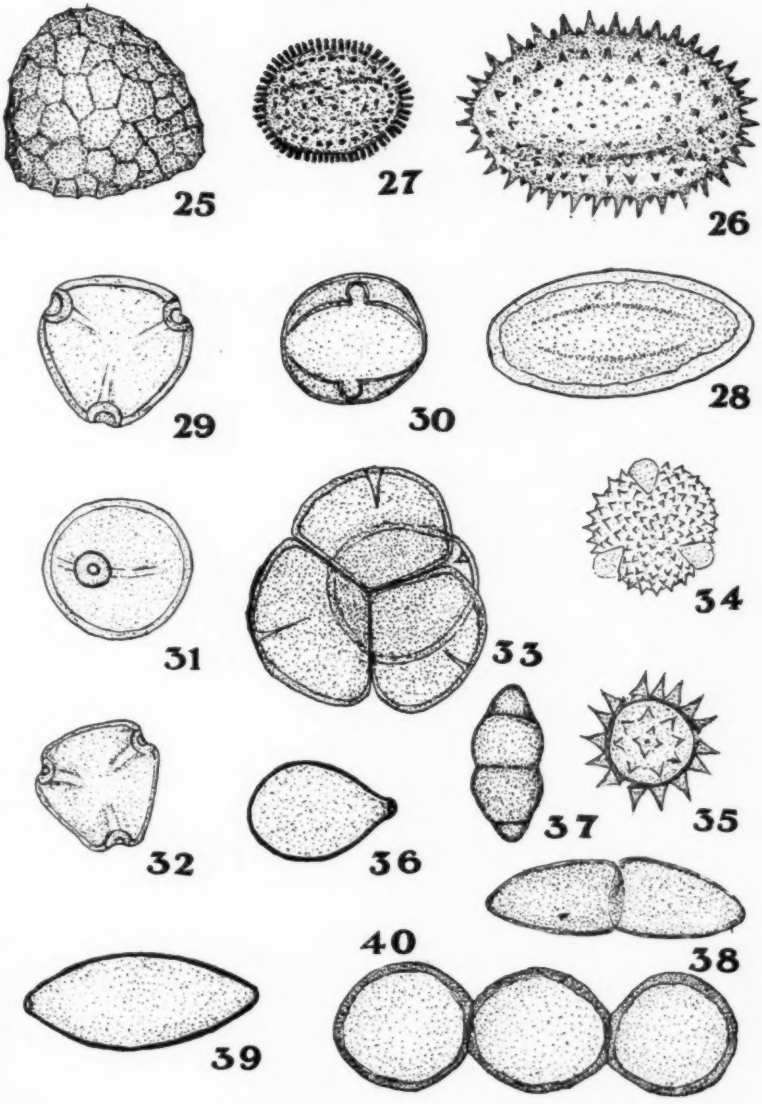
PLATE 5



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FLORA OF THE TRYON REGION

Part IV. Mimosa Family to Dogwood Family (Mimosaceae to Cornaceae)

By Donald Culross Peattie

Family 58. MIMOSACEAE (Mimosa Family)

514. **Albizzia Julibrissin** Durazzini. ("Mimosa")

Though called mimosa, this tree is not a true mimosa, any more than the acacias that are often so called. A native of Asia, it is one of our commonest cultivated trees, and is abundantly naturalized. Specimens: Tryon, (fls. & fr.) July 22, 1921 (PT. no. 1038).

515. **Schrankia angustata** T. & G. (Sensitive Brier)
Morongia angustata Britton.

This interesting little trailing, prickly perennial herb of vine-like appearance, has attractive flowers closely akin to those of the true mimosa or sensitive plant of the tropics, and is much more nearly related to it than the foregoing species. Common on the Cecil clays of the piedmont. Specimens: Huston Farm, near Columbus, Aug. 26, 1897 (Towns.). Railroad embankment, July 3, 1921 (PT. no. 820). Begins to bloom about the twentieth of June.

Family 59. CAESALPINIACEAE (Senna Family)

516. **Gleditsia triacanthos** L. (Honey Locust)
Gleditsia spinosa Marsh.

This fine tree is much planted around old farmyards; it is said to be native west of the mountains; abundantly naturalized. Specimen: "The Shoals," May 1918 (Millsp. no. 4105).

517. **Chamaecrista nictitans** (L.) Moench. (Wild Sensitive Plant)
Cassia nictitans L.

This little herb with somewhat sensitive leaves is common in the Cecil clays of the piedmont. Specimens: Columbus, June 26, 1897 (Towns.). Roadsides and dry soil, Tryon, Aug. 10, 1921 (PT. no. 1152).

518. **Chamaecrista fasciculata** (Michx.) Greene (Partridge Pea)
Cassia fasciculata Michx.
Cassia Chamaecrista of auths., not L.
Chamaecrista Chamaecrista of auths.

Rather a handsome flower of the Cecil clays on the piedmont. Specimens: Huston Farm near Columbus, July 28, 1897 (Towns.). Dry soil, Tryon, Aug. 9, 1921 (PT. no. 1150).

519. **Cassia Tora** L. (Wild Senna)

Occasional in dry sandy soil of the eastern part of the county. Specimen: Millspring, Aug. 14, 1899 (Towns.).

520. **Cassia marilandica** L. (Wild Senna)

This undoubtedly occurs in our area, in alluvial soil, but Townsend's specimen, Aug. 18, 1897, comes from just over the Rutherford County line.

521. **Cassia ligustrina** L.

This native of the West Indies has not previously been reported from North Carolina so far as I know. It is undoubtedly escaped from cultivation and is now naturalized. Briefly it may be described as similar to *C. marilandica*, but is a shrub about 1.5 meters high, with leaflets acute at tip, cuneate at base, 2.5 cm. long or less, 8 mm. wide or less, not ciliate, dark green and shining above, paler beneath, with the odor of box; wood springy and tough, bark pale and privet-like. Specimens: Tryon, Aug. 9, 1921 (PT. nos. 1144–1146). Identified by Dr. Rose.

522. **Cercis canadensis** L. (Redbud. Judas Tree)

This odd and beautiful little tree that is one of the characteristic features of the spring landscape, is common in the Porter soils of the piedmont and of those mountain slopes that are sunny. Specimens: Tryon, March 21, 1897 (Towns.). Tryon, March 24, 1911 (Day).

Melrose, April 10, 1923, and Tryon, (fr.) June 20, 1921 (PT. nos. 1834, 612).

Family 60. FABACEAE (Bean or Legume Family)

523. **Baptisia tinctoria** (L.) R. Br. (Wild Indigo)
Sophora tinctoria L.

Abundant in poor soil, hot, thin woods, etc., on the piedmont. Specimens: Columbus, June 14, and Tryon, June 23, 1897 (Towns.). Dry pine woods and roadsides, June 20, 1921 (PT. no. 632). The above are commencement dates; blooms into August.

524. **Thermopsis mollis** (Michx.) M. A. Curtis
Podalyriax mollis Michx.

This splendid endemic species is occasional in pine woods. Specimen: Piney Mt., May 8, 1919 (Day).

525. **Thermopsis caroliniana** M. A. Curtis.

Another showy endemic, less frequent, in mountain woods. Specimen: Near Melrose Mt., Tryon, June 2, 1897 (Towns.).

526. **Crotolaria sagittalis** L. (Rattle-box)

This curious little plant, chiefly found on the coastal plain, has been collected in our area just once. Specimen: Huston Farm, near Columbus, (fr.) July 14, 1897 (Towns.). It begins to bloom in June.

527. **Trifolium repens** L. (White Clover)

Introduced from Europe, cultivated, and escaped. Common. Specimen: Godshaw Hill, May 23, 1926 (PT. no. 2213).

528. **Trifolium hybridum** L. (Alsike Clover)

Introduced from Europe, cultivated, and escaped. Rare. Specimen: Tryon, May, 1918 (Millsp. no. 4088).

529. **Trifolium agrarium** L. (Yellow or Hop Clover)

Introduced from Europe, cultivated and escaped. Occasional. Specimen: Tryon, June 24, 1921 (PT.).

530. **Trifolium procumbens** L. (Low Hop Clover)

Introduced from Europe, cultivated, and escaped. Common. Specimens: South of Columbus, May 29, 1899 (Towns.). Tryon, May 12, 1919 (Day). Tryon, May 18, 1918 (Millsp. no. 4078).

531. **Trifolium incarnatum** L. (Crimson or Italian Clover)

Introduced from Europe, cultivated, and escaped. Occasional. Specimen: Tryon, May 1918 (Millsp. no. 4139).

532. **Trifolium pratense** L. (Red Clover)

Introduced from Europe, cultivated, and escaped. Common. Specimen: Tryon, May 23, 1926 (PT. no. 2222).

533. **Trifolium reflexum** L. (Buffalo Clover)

Apparently absent from the western part of the county, this, the only native clover, is frequent in the sandy soils of the eastern part. Specimens: Huston Farm, 1899 (Towns.). Near a bridge over Walnut Creek, one mile from the county line on the Rutherfordton road, May 26, 1927 (Wherry). Reported from Pea Ridge by Mr. Edgar Upton.

534. **Melilotus alba** Desr. (Sweet Clover)

Naturalized from Europe; common around fields and roadsides. Specimen: June 24, 1921 (PT.).

535. **Melilotus officinalis** (L.) Lam. (Yellow Melilot)
Trifolium officinalis L.

Naturalized from Europe, and only spreading into our area in the last few years; still rare. Specimen: Railroad track, Tryon, May 5, 1926 (PT. no. 2139).

536. **Medicago sativa** L. (Alfalfa)

Introduced from Europe, cultivated, and escaped. Frequent. Specimen: Fencerows, May 23, 1926 (PT. no. 2274)

537. **Amorpha glabra** Poiret (False Indigo)
Amorpha montana Boynton, not *A. glabra* Boynton

This beautiful shrub is common in the Porter soils of the foothills and shaded mountain ravines. Specimens: Fox Mt., May 10, 1897 (Towns.). "Skuyuka," May 1899 (Church.). Tryon, April 30, 1919 (Day). Skuyuka road, in rich woods, (fr.) July 21, 1921 (PT. no. 1032). Three miles north of Millspring, May 26, 1927, and on s.w. ridge of Hogback Mt., May 27, 1927 (Wherry). Top of White Oak Mt., May 1918 (Millsp. no. 4200).

538. **Psoralea macrophylla** Rowlee.

So far as is known, this species has never been collected anywhere except on Tryon Mt., and was described entirely from Townsend's specimens: June 18, 1897. It is striking in its difference from all other species, though nearest to *P. Onobrychis*, amongst eastern species; it is said to bear a resemblance to the Californian species, *P. macrostachya*, and *P. glandulosa*. I give below the original description, as found in Rowlee's manuscript: 0.5–1.5 meters tall, erect, simple but for the naked elongated floriferous branches from the axils of the uppermost leaves; stem rather stout, prominently 6-angled, with 1 or 2 lower intermediate angles, hairy especially on the ridges; leaves pinnately 3-foliate, petiole 6–8 cm. long; terminal leaflet raised 2 cm. above the lateral ones; leaflets broadly ovate, 6–7 cm. long by 5–6 cm. wide, entire, cordate, obtuse, finely pubescent on the veins, otherwise glabrous and green on both sides, veiny beneath; stipules linear; spikes cylindrical, loosely flowered, often the lowest verticel of flowers 2 cm. below the remainder of the spike; pedicel longer than the spike, often 20 cm., the axis of the spike, bracts, and calyx glandular-hairy; bracts short and deciduous, scarcely longer than the pedicel of the flower; calyx nearly regular, reticulate-veiny within; ovary pubescent; corolla purple.

539. **Tephrosia virginiana** (L.) Pers. (Goat's Rue. Devil's Shoestring).

Cracca virginiana L.
Galega virginiana L.
Tephrosia holosericea Nutt.

Common in light woods or open soil, especially on the piedmont. Specimens: Tryon, May 10, 1897 (Towns.). Tryon, May 14, 1919 (Day). In dry woods, Columbus, (fr.) July 28, 1921, and on Godshaw Hill, (fls.) June 29, 1921 (PT. nos. 1089, 726).

540. **Tephrosia spicata** (Walt.) T. & G. (Catgut. Hoary Pea)
Galega spicata Walt.
Cracca spicata Ktze.

Less common than the preceeding, but in similar localities. Specimens: Huston Farm, near Columbus, June 29, 1897 (Towns.). Godshaw Hill, Tryon, July 19, 1921 (PT. nos. 980, 970, 969).

541 **Robinia Pseudo-Acacia** L. (Black Locust).

This well-known tree is common with us, throughout, but especially in the foothills. Specimens: Tryon, April 30, 1919 (Day). "Valhalla" July 23, (fr.) 1921 (PT. no. 1063).

542. **Robinia viscosa** Vent. (Clammy Locust)

According to Pinchot and Ashe ("Timber Trees of N. C.") this is sometimes classed as a tree, but they state that "In this state it is found on Buzzard ridge in Macon county, growing as a shrub only a few feet high. It has not been seen growing wild in any other locality since the time of Michaux." In our area it certainly occurs, and I believe it to be more widespread in the mountains than Pinchot and Ashe allow. The only difficulty is that it is too near the following species in its diagnostic characters, and is probably often confused with it. Specimens: Tryon, May 1897 (Towns.). Hills above the Pacolet, April 28, 1926 (PT. no. 2122). Mention must also be made here of a specimen in the Nat. Herb., which bears the following information: "*Robinia longiloba* Ashe. Plant from near Tryon, N. C., cultivated at Washington, D. C. May 30, 1922. One mile above Tryon, south side of railroad; fine clump." The specimen was collected and labelled by Ashe, and therefore constitutes what might be considered a type specimen of his species *Robinia longiloba*, although he has not designated any particular type. In his description of it in *Bull. Charleston Mus.* **12**, p. 38 (1916), he says, "Similar to *R. hispida* but with a narrower pod, and less hispid; flowers more numerous and more glandular than in *R. nana*." How far this species, on paper, is validly distinct from others only study will prove, but the particular specimen from our area does not at all fit this description, and, indeed, I see no reason why it is not simply a specimen of *R. viscosa*.

543. **Robinia hispida** L. (Rose Acacia)

Fairly frequent on exposed mountain crests; also cultivated in Tryon; one of the most splendid of American shrubs. Specimens: White Oak Mt., May 1918 (Millsp. no. 4090). On Hogback Mt., (not in fl.) Sept. 17, 1927 (Wherry).

544. **Robinia Kelseyi** Cowell (Dwarf Locust)

This report is based on Townsend's specimen in the Nat. Herb., for which he gives no data except that it is a Polk County plant. He labelled it *R. viscosa*, but Prof. Rydberg has marked it as *R. Boyntoni*. In my opinion it corresponds in every way to Cowell's description except for a few minute hairs on the lower midribs of the leaves.

545. **Robinia nana** Spach (Dwarf Locust)

Frequent in the light warm woods of the foothills. Specimens: Tryon, May 1899 (Church). Tryon, April 20, 1919 (Day).

546. **Wisteria macrostachya** Nutt. (Wistaria)
Kraunhia macrostachya Small

This is the most unusual of the "finds" in Millspaugh's collection. His specimen, no. 4048, is from Little Warrior Mt., May 1918. Gray's Manual says of this species "rich soil, swamps, etc., Ind. (?) to Mo., Kan. (?), and La." Millspaugh called his specimen *Wisteria speciosa*, but it is quite certainly *W. macrostachya*. The nearest station to ours seems to be in western Tennessee, though of course *W. frutescens* is found on the coastal plain of North Carolina. Much cultivated in our area is the Japanese wisteria, *W. floribunda* DC., and this shows a tendency to naturalize itself.

547. **Astragalus canadensis** L. (Milk Vetch)
Astragalus carolinianus L.

Though this interesting plant is wide-spread on the continent it is certainly not common in the Southern States. In our area at least it is distinctly anomalous; the only specimens are: Side of Tryon Mt., July 11, 1899 (Towns.).

548. **Desmodium nudiflorum** (L.) DC. (Tick Trefoil)
Hedysarum nudiflorum L.
Meibomia nudiflora Ktze.

Perhaps the commonest species of the genus, abundant in dry woods. Specimens: On Godshaw Hill, Tryon, (fls. only) July 9, 1921, and in dry soil, Tryon, (fr.) Aug. 11, 1921 (PT. nos. 977, 1193).

549. **Desmodium grandiflorum** (Walt.) DC. (Tick Trefoil)
Hedysarum grandiflorum Walt.
Hedysarum acuminatum Michx.
Meibomia grandiflorum Ktze.

Common in rich woods. Specimens: Columbus, Aug. 23, 1897 (Towns.). On Tryon Mt. (fls. only), June 30, 1921 (PT. nos. 806, 807).

550. **Desmodium rotundifolium** (Michx.) DC. (Tick Trefoil).
Hedysarum rotundifolium Michx.
Meibomia rotundifolia Ktze.
Meibomia Michauxii Vaill.

Occasional in dry soil. Specimen: Columbus, Aug. 1897 (Towns.). Tryon, May 1918 (Millsp. no. 4175).

551. **Desmodium canescens** (L.) DC. (Tick Trefoil).
Hedysarum canescens L.
Meibomia canescens Ktze.

Frequent in dry soil and woods. Specimens: Tryon, Aug. 9, 1921 (PT. no. 1143). Dry woods, Tryon, Sept. 15, 1926 (Hunnew. no. 10,008).

552. **Desmodium laevigatum** (Nutt.) DC. (Tick Trefoil).
Hedysarum laevigatum Nutt.
Meibomia laevigata Ktze.

Common in woods. Specimens: Moist banks, Melrose, (fls. & fr.) Sept. 12, 1921 (PT. no. 1498). Tryon, (young fr.) Sept. 15, 1926 (Hunnew. no. 9986).

553. **Desmodium viridiflorum** (L.) Beck. (Tick Trefoil).
Meibomia viridiflora Ktze.

Townsend's specimen, mountainsides, Columbus, 1897, was identified for me by Dr. Wiegand. It is the only collection.

554. **Desmodium Dillenii** Darl. (Tick Trefoil).
Meibomia Dillenii Ktze.

Townsend collected this species twice in 1897, once at Spring Mt. Park and again on Tryon Mt. Identification by Dr. Wiegand.

555. **Desmodium paniculatum** (L.) DC. (Tick Trefoil).
Hedysarum paniculatum L.
Meibomia paniculata Ktze.

Abundant in woods and fields. Specimens: Spring Mt. Pk., Sept. 8, 1897 (Towns.). Open ground, Tryon, (fr.) Aug. 9, 1921, and in rich woods, Pearson's Falls, (fr.) Sept. 12, 1921 (PT. nos. 1140, 1504).

556. **Desmodium obtusum** (Muhl.) DC. (Tick Trefoil).
Meibomia obtusa Vaill.

In dry woods, occasional. Specimen: Tryon, (fr.) Sept. 15, 1926 (Hunnew. no. 9948).

557. **Desmodium marilandicum** (L.) DC. (Tick Trefoil).
Hedysarum marilandicum L.
Meibomia marilandica Ktze.

In dry woods. Specimen: Tryon, Aug. 23, 1897 (Towns.).

558. **Desmodium lineatum** (Michx.) DC. (Tick Trefoil).
Hedysarum lineatum Michx.
Meibomia arenicola Vaill.

Frequent in dry woods of the piedmont. Specimen: Columbus, July 28, 1921 (PT. no. 1088).

559. **Lespedeza procumbens** Michx. (Bush Clover).

Dry sandy soil, frequent on the piedmont. Specimen: Huston Place, Sept. 1899 (Towns.).

560. **Lespedeza repens** (L.) Bart. (Bush Clover).
Hedysarum repens L.
Lespedeza prostrata Pursh

Frequent in dry open soil. Specimens: Godshaw Hill, Tryon, July 3, 1921, and July 19, 1921 (PT. nos. 821, 973).

561. **Lespedeza Nuttallii** Darl. (Bush Clover).

There is but one specimen: Spr. Mt. Park, Aug. 25, 1898 (Towns.).

562. **Lespedeza Stuvei** Nutt. (Bush Clover).

The only collection of this is Townsend's: Spring Mt. Pk., Sept. 1, 1897.

563. **Lespedeza intermedia** (Wats.) Britton (Bush Clover).
Lespedeza frutescens Britton, not *Hedysarum frutescens* L.

Frequent in woods. Specimens: Forests, Tryon, (fr. only) Oct. 18, 1926 (PT. no. 2398). Spring Mt. Park, Aug. 25, 1897 (Towns.).

564. **Lespedeza hirta** (L.) Horneman (Bush Clover).
Hedysarum hirta L.
Lespedeza polystachya Michx.

Common in dry soil and light woods. Specimens: Spring Mt. Pk., Aug. 28, 1897 (Towns.). Dry soil, Tryon, Aug. 11, 1921, and wet woods, Tryon, (fr.) Aug. 24, 1921 (PT. nos. 1180, 1373).

565. **Lespedeza striata** (Thunb.) H. & A. (Bush Clover).

Common dooryard and roadside weed, naturalized from Asia. Specimen: Along the railroad track, in cinders, Tryon, Aug. 8, 1921 (PT. no. 1108).

566. **Stylosanthes riparia** Kearney (Pencil Flower).

Common in dry open soil, roadsides, etc. Specimens: Green Farm near Columbus, June 14, 1897 (Towns.). Railroad embankment, June 20, 1921 (PT. no. 641). Miss Wright reported *S. biflora*, but this is possibly an error.

567. **Vicia caroliniana** Walt. (Wild Vetch).
Vicia parviflora Michx.

This delicate and pretty little species is common in Porter soils or richer top soils of the piedmont clays throughout. Specimens: Tryon, April 1, 1897 (Towns.). Roadsides, Tryon, April 16, 1922 (PT. no. 1602).

568. **Vicia Cracca** L. (Purple Vetch).

Frequent in open fields. Specimens: Pacolet valley fields, June 20, 1921 (PT. nos. 628, 629).

569. **Vicia sativa** L. (Spring Vetch).

Introduced from Eurasia and common as a naturalized weed. Specimens: Tryon, April 30, 1919 (Day). Along the railroad and in fields, April 20, 1923, and on Godshaw Hill, Tryon, May 23, 1926 (PT. nos. 1873, 2219).

570. **Vicia villosa** Roth. (Winter Vetch).

Introduced from Eurasia and commonly naturalized. Specimens: Roadsides, Tryon, April 30, 1919 (Day). Edges of cultivated fields, Godshaw Hill, May 3, 1926 (PT. no. 2128).

571. **Lathyrus latifolius** L. (Everlasting Pea).

Native of Europe, cultivated in gardens and escaped to woods and thickets. Specimen: Tryon, May 23, 1926 (PT. no. 2240).

572. **Glycine Apios** L. (Groundnut).
Apios Apios MacMillan
Apios tuberosa Moench.

This handsome herbaceous climber with clusters of curious brown flowers having the odor of violets, and bearing edible tubers, is very common in woods and thickets. Specimens: Millspring, Aug. 17, 1897 (Towns.). In woods, Tryon, Aug. 11, 1921, and in low thickets, Columbus, Aug. 20, 1921 (PT. nos. 1158, 1323).

573. **Strophostyles helvola** (L.) Britton (Wild Bean).
Phaseolus helvola L.
Phaseolus trilobus Michx.
Glycine angulosa Muhl.
Strophostyles angulosa (Ort.) Ell.

Common in roadside thickets. Specimens: Tryon, June 20, 1919 (PT. 0296). Tryon, Sept. 15, 1926 (Hunnew. no. 10,007).

574. **Clitoria mariana** L. (Butterfly Pea).
Terneata mariana Ktze.

This splendid lilac-flowered species is abundant all summer in woods, thickets, and on dry banks and mountain rocks. Specimens: Mountainsides, Tryon range, June 19, 1897 (Towns.). "Valhalla," June 30, 1921 (PT. no. 814).

575. **Centrosema virginiana** (L.) Benth.
Clitoria virginiana L.
Bradburya virginiana Ktze.

Sandy woods, occasional. Specimen: Fox Mt., Aug. 10, 1897 (Towns.).

576. **Amphicarpa monoica** (L.) Ell. (Hog Peanut).
Glycine comosa L.
Glycine bracteata L.
Glycine monoica L.
Falcata comosa Ktze.

Common in rich damp woodlands. This plant is well known for ripening some of its fruits underground, like the true peanut (*Arachis hypogaea* L.). Specimens: Columbus, 1897 (Towns.). Tryon, Aug. 31, 1921 (PT. no. 1481).

577. **Galactia volubilis** (L.) Britton (Milk Pea).
Hedysarum volubilis L.
Galactia mollis Nutt.
Galactia pilosa Ell.

Common in dry soil. Specimens: Tryon, July 22, 1897 (Towns.). Godshaw Hill, Tryon, July 17, 1921 (PT. no. 968).

578. **Pueraria Thunbergiana** (Sieb. & Zucc.) Benth. (Kudzu Vine).

Introduced from Asia, much cultivated, and naturalized. Specimen: Railroad track, Tryon, Aug. 11, 1921 (PT. no. 1161).

Family 61. LINACEAE (Flax Family).

579. **Linum usitatissimum** L. (Common Flax).

Introduced from Europe, formerly cultivated, and now much naturalized. Its considerable presence in our area may be a relic of flax culture dating from Colonial times. Up to a short time ago flax was still grown

for linen in the Carolina mountains for native weaving, its culture in the northwestern states being of modern origin and for linseed oil. The oil of the seed is or was a local country medicine, as an emollient. Specimen: Tryon, May 1918 (Millsp. no. 4077).

580. **Linum virginianum** L. (Wild Flax).
Cathartolinum virginianum Reichenb.

Common in dry open soil. Specimen: Godshaw Hill, Tryon, June 29, 1921 (PT. no. 766).

Family 62. OXALIDACEAE (Wood Sorrel Family)

581. **Oxalis violacea** L. (Violet Wood Sorrel).
Ionoxalis violacea Small

Common in woods or open sandy ground. Specimens: Side of Tryon range, May 1, 1898 (Towns.). Tryon, (fls. only, no leaves!) Aug. 29, 1921, and muddy ground, golf links, April 19, 1922 (PT. nos. 1419, 1652).

582. **Oxalis grandis** Small (Giant Wood Sorrell).
Xanthoxalis grandis Small
Oxalis recurva Trelease

Rare, in sandy alluvial woods. Specimens: Lynn, May 20, 1899 (Church.). "Valhalla" May 22, 1919 (PT. no. 0231).

583. **Oxalis recurva** Ell. (Wood Sorrel).

Wiegand in his monograph in Rhodora **27**, p. 137 (1925), cites the following specimen: Columbus, 1900 (Towns.).

584. **Oxalis europaea** Jordan (Lady's Sorrel).
Oxalis corniculata of Gray's Man., not L.
Oxalis cymosa Small
Xanthoxalis cymosa Small
Oxalis rufa Small

Common in woods, thickets, and fields. Specimens: Side of Tryon Mt., July 1, 1899 (Towns.). In tall wet grass, "The Shoals," Aug. 20, 1921 (PT. no. 1308).

585. **Oxalis stricta** L. (Wood Sorrel).
Xanthoxalis stricta Small

Common in lawns and around dooryards. Specimens: Tryon, May 1918 (Millsp. no. 4043). In lawns, Tryon, April 24, 1923, and May 23, 1926 (PT. nos. 1876, 2221).

Family 63. GERANIACEAE (Geranium Family)

586. **Geranium maculatum** L. (Wild Geranium).

Common in richer soils of woods and meadows throughout. Specimens: Tryon Mt., June 4, 1899 (Towns.). Hillsides, Tryon, April 16, 1922 (PT. no. 1604).

587. **Geranium carolinianum** L. (Cranesbill).

Common by roadsides, as a weed of cultivation, along railroad tracks, etc., but also native. Specimens: Columbus, May 18, 1899 (Towns.). Cultivated lands, Tryon, April 16, 1922 (PT. no. 1620).

588. **Geranium molle** L. (Cranesbill).

Common little European weed. Specimens: Cultivated land, Tryon, April 12, 1919 (Day). Lawns, Tryon, April 21, 1922 (PT. no. 1651).

Family 64. RUTACEAE (Citrus Family)

589. **Ptelea trifoliata** L. (Hop Tree).

This peculiar shrub is rare in our area; most collectors, including the writer, have not found it. Miss Wright reports it from Log Cabin Inn, on White Oak Mt., June 3. The only established specimen is Townsend's: Spring Mt. Park, June 7, 1897.

Family 65. MELIACEAE (Mahogany Family)

590. **Melia Azederach** L. (China-berry).

This tree, native of S. W. Asia, is perhaps the most popular of cultivated trees around old farms of the piedmont. Commonly escaped from cultivation, or persistent in abandoned places. Specimens: Old Mill's Estate, (fr.) Aug. 9, 1921 (PT. no. 1151). It blooms in May and June.

Family 66. POLYGALACEAE (Milkwort Family)

591. **Polygala polygama** Walt. (Milkwort).
Anthalogea polygama Raf.

A peculiar, handsome little plant found locally in dry wood loams and on hillsides. Specimens: Saluda, June 24, 1897 (Towns.). "Valhalla," May 12, 1919 (PT. no. 0220).

592. **Polygala sanguinea** L. (Milkwort)
P. viridescens L.
P. purpurea Nutt.
P. viridescens var. *sanguinea* Farwell

Frequent in dry open soil, or thin thickets. Specimens: Roadside between Millspring and Chimney Rock, July 17, 1897 (Towns.). Roadsides on the Tryon-Saluda road, northwest of Howard's Gap, in dry soil, June 30, 1921 (PT. no. 798).

593. **Polygala verticillata** L. (Milkwort)

Occasional in dry open soil. Specimen: "Huston Farm" near Columbus, June 28, 1897 (Towns.).

594. **Polygala ambigua** Nutt. (Milkwort)
Polygala verticillata var. *ambigua* Wood

Frequent in dry open soil. Specimens: Tryon Mt., July 1, 1897 (Towns.). Godshaw Hill, along roadsides, June 29 and July 18, 1921 (PT. nos. 768, 979).

Family 67. EUPHORBIACEAE (Poinsettia Family)

595. **Croton glandulosus** L. var. **septentrionalis** Muell. Arg.

In sandy thickets and sterile open ground, as a little native weed, common. Specimens: Millspring, Aug. 14, 1899 (Towns.). Godshaw Hill, (fr.) Nov. 3, 1926 (PT. no. 2387).

596. **Crotonopsis linearis** Michx.

In open sandy soil, as a little native weed, common. Specimens: Tryon, (fls. & fr.) July 19 and July 25, 1921 (PT. nos. 997, 998, 1072).

597. **Acalypha gracilens** Gray (Three-seeded Mercury)

Common in dry open soil. Specimens: "Huston Farm" near Columbus, July 14, 1897 (Towns.). Saluda, Aug. 8, 1921 (PT. no. 1112).

598. **Acalypha virginica** L. (Three-seeded Mercury)

Common as a native weed-like species, in dry open soil. Specimens: Waste ground, Tryon, Aug. 9, 1921, and (fr.) Nov. 13, 1926 (PT. nos. 1121, 2384).

599. **Tragia nepetaefolia** Cav.
Tragia urticaefolia Michx.

There seems to be only one specimen of this: "White Oak Creek, on the Rutherfordton Road," Sept. 16, 1897 (Towns.). Doubtless it occurs elsewhere in the eastern part of the county.

600. **Tragia urens** L.
Tragia innocua Walt.

This has been collected but once, a single plant of it being found by the writer. Specimen: Along Vaughan's Creek, near the foot of Hogback Mt., (fr.) Aug. 13, 1921 (PT. no. 1227).

601. **Euphorbia maculata** L. (Milk Purslane)

A common little dooryard and roadside native weed.

602. **Euphorbia Preslii** Guss. (Spurge)
Chamaesyce Preslii Arthur
Euphorbia hypericifolia of auths., not L.
Euphorbia nutans Lag.

A common native weed of open dry soil especially around houses and in cultivated fields. Specimens: Godshaw Hill, Tryon, (all in fr.) Oct. 29 and Nov. 31, 1926 (PT. nos. 2375, 2385). A specimen of Townsend's, "Huston Farm," July 14, 1897, is so widely different as to appear like a new species, having pubescent nodes, low, unbranched stems, and only one or two inflorescences, the leaves a bright, light green, shorter, broader, and thicker than in the ordinary specimens. An inspection of specimens in the National Herbarium shows however that this

is a polymorphic species with innumerable connecting specimens so that no separations can be made.

603. **Euphorbia corollata** L. (Flowering Spurge)
Tithymalopsis corollata Kl. & Garcke
Agaloma corollata Raf.

Very common in woods, meadows, and roadsides; often locally called a milkweed. There appear to be many different forms. Specimens: Side of Tryon Mt., July 11, 1899 (Towns.). This specimen is peculiar in having only the topmost leaves whorled and all the leaves very broadly lanceolate. Tryon, May 1899 (Church.). Tryon, May 20, 1926 (PT. no. 2200). This specimen has very few flowers, sometimes only one. Near bridge over Walnut Creek, one mile inside Polk County line on the Rutherfordton road, May 29, 1927 (Wherry). This specimen has very short leaves, villous stems, and very few flowers.

Family 68. ANACARDIACEAE (Cashew Family)

604. **Rhus typhina** L. (Staghorn Sumac)
Datisca hirta L.
Rhus hirta Sudw.
Rhus canadensis Mill., not Marsh.
Toxicodendron typhinum Ktze.
Schmaltzia hirta Small

This slender tree or tall shrub is frequent on well-drained slopes, or in little bottom lands of small streams. Specimen: Vaughan's Gap, near the foot of Hogback Mt., (lvs. and bark) Sept. 6, 1921 (PT. nos. 1482–1484). Blooms in early summer.

605. **Rhus copallina** L. (Winged Sumac)
Toxicodendron copallinum Ktze.
Schmaltzia copallina Small

Common along streams and in thickets on hillsides. Specimens: "Huston Farm" near Columbus, July 29, 1897 (Towns.). Tryon, (lvs. only) Aug. 9, 1921 (PT. no. 1149).

606. **Rhus glabra** L. (Common Sumac)
Rhus carolinense Marsh.

Toxicodendron glabra Ktze., not Mill.
Schmaltzia glabra Small

Very common throughout, especially in sunny thickets. Specimens: Side of Tryon Mt., June 15, 1899 (Towns.). Melrose Mt., June 27, 1921 (PT. no. 685). This and the foregoing species are all locally used by country people for dyes and tannin.

607. **Rhus Toxicodendron** L. (Poison Ivy)
Toxicodendron Toxicodendron Britton
Toxicondendron pubescens Miller
Toxicodendron radicans Ktze.

Common in woods, thickets, and fields. There are many variations, from climbing or reclining plants to low erect shrubs and tall shrubs of a straggling but almost tree-like nature. Leaves, too, are of various shapes, from entire to considerably lobed, and glabrous to markedly pubescent. Many species and varieties have been separated on the basis of these variations but I think McNair's view that they are all one species is best. In his "Rhus Dermatitis" he cites as typical Millspaugh's specimen from Tryon, May 1918 (no. 4060). Another specimen is: Vaughan's Gap, below Hogback Mt., Aug. 13, 1921. This was almost a tree (PT. no. 1232). There are also many interpretations of Linnaeus's and Miller's botanical names, but it is evident that Linnaeus was trying, lacking field knowledge, to base a difference on the climbing and the erect habit, which is futile, and Miller was dividing species on pubescence, which has also proved unsound. I see no justification for assuming that Linnaeus by the name used above intended the poison-oak, *R. quercifolia* (Michx.) Steud., the distinguishing characteristics of which he does not set forth under the description of *R. Toxicodendron.* Many recent authors on southern botany do however follow this practice.

Family 69. ILICACEAE (Holly Family)

608. **Ilex verticillata** (L.) Gray (Black-alder. Winterberry)
Prinos verticillata L.
Prinos Gronovii Michx.

This shrub, which is well known in the lower altitudes of the Eastern United States, seems to have been collected here only once. Specimen: Near Columbus, June 6, 1899 (Towns.). This specimen is remarkable for having a markedly tomentose calyx, in addition to the cilia on the

sepal margins, in this respect, but not at all in others, resembling *Ilex Beadlei*. In leaf form this specimen is typical *I. verticillata* rather than any of the varieties that have been described. The berries, in autumn, are very ornamental.

609. **Ilex monticola** Gray (Mountain Holly)
Ilex dubia B.S.P.

Frequent in mountain and foothill woods. Specimens: Tryon, (male flowers) May 12, 1919 (Day). Damp woods, Vaughan's Gap, between Hogback and Rocky Spur, (fruit) Aug. 14, 1921 (PT. nos. 1217, 1218).

Var. *mollis* (Gray) Britton

Frequent in the same habitats as the typical species. Specimens: Saluda, May 1899 (Church.). Vaughan's Creek, April 21, 1922 (PT. no. 1689).

610. **Ilex opaca** Ait. (Evergreen Holly)
Ilex canadensis Marsh.
Ageria opaca Raf.

This well-known and beautiful tree is frequent both in the mountains and on the piedmont, in Porter and Cecil soils. Its continued exploitation for Christmas decoration endangers it in our area. Specimen: Tryon, May 18, 1911 (Day). Fruits in early winter.

Family 70. CELASTRACEAE (Bittersweet Family)

611. **Celastrus scandens** L. (Bittersweet)

This strong vine, with superb ornamental fruits in winter, is stated by Coker ("Our Mountain Shrubs") to be very rare in North Carolina. He cites as stations of its occurrence: Biltmore, Cane Creek in Mitchell Co., Spruce Pine, Scheville, and adds: "Curtis knew of but one vine, which was near Lincolnton." In our area, too, it is distinctly rare, having been collected just once. Specimen: Lower Shunkawawkin Falls, in mountain woods, May 22, 1897 (Towns.).

612. **Evonymus americanus** L. (Strawberry Bush)

Very common shrub, throughout the piedmont region, and not infrequent in the mountains; it prefers the banks of streams, under

shade. It is frequently, when in flower, to be seen swarming with ants, which are its pollinators. Specimens: Shunkawawkin Falls, May 19, 1897 (Towns.). Tryon, May 18, 1911 (Day). Vaughan's Creek, (fruit) Aug. 11, 1921, and "Glen Walden," (fruit bursting open, in ornamental stage) Dec. 24, 1920 (PT. nos. 1168, 1579). Sometimes planted for ornament, but not so much so as the handsome *Evonymus japonicus*.

Family 71. ACERACEAE (Maple Family)

613. **Acer rubrum** L. (Red Maple)

This tree is almost the commonest in our area, and is found at all altitudes and in a variety of situations; it is most characteristic of the slopes of the foothills. Specimens: Tryon, (fruit and young leaves) April 6, 1919 (Day). Melrose, (fruit only) April 10, 1923; Melrose Mt. (a huge specimen with old bark tending to scale almost like the segments of sugar-maple bark; leaves, but no flowers or fruit) Aug. 29, 1921; Melrose, (fruit and young leaves) April 20, 1922 (PT. nos. 1803, 1414, 1415, 1670). The flowers are, with the alder and hazel, the first to bloom in spring, appearing in February and March; some may even be found in a warm spell in January. The variability of the high autumn coloration of the leaves leads many to suppose that there must be various "species" of red maple, but there is no reason to believe this. The leaves may be three- or five-lobed.

614. **Acer carolinianum** Walt. (Carolina Maple)
Acer rubrum var. *tridens* Wood
Acer microphyllum Pax
Acer tomentosum of Pax but not certainly of Desfontaines

Frequent, on the piedmont and in foothills, perhaps sometimes in the mountains. Specimens: A large tree, "Dark Corners" (foot of Rocky Spur), Aug. 13 and 14, 1921; Tryon, Aug. 23, 1921 (PT. nos. 1267, 1268, 1362). These specimens are in leaf only.

This species is often confused with the tri-dentate form of *Acer rubrum*, partly owing to the fact that many books do not point out all the differences between the two species. In typical *Acer rubrum* the bark is sometimes light gray and smooth in saplings, but is generally dark gray and in age becomes rugged; leaves are thin, light green above and pale beneath but not, or barely, glaucous, and are ultimately smooth,

with the veins, except for the midrib, not particularly prominent; the lobes of the leaves are 5, the three middle ones prominent, the two lateral small, while the sinuses between the lobes are acute, as are the rather numerous lobes. Flowers and narrow samaras red.

In the tridentate form of the red maple all is similar except that the leaves are smaller, there are but three lobes, and the two lateral ones are rather forward-pointing, the resultant sinuses distinctly acute; the teeth are rather fewer than in the 5-lobed form, but are acute.

The Carolina maple on the other hand has light gray and almost smooth bark, even in age; the leaves are thick, almost leathery, dark green and shining above, and heavily glaucous beneath, with persistent flocculence in the axils of the nerves; the nerves quite prominent beneath; lobes three, broad, the two lateral widely spreading, the sinuses between them broad and scarcely acute; teeth few or obscure, low, and broadish; flowers yellow; broader samara yellow.

The name *Acer tomentosum* Desfontaines has been cited so many times as the earliest correct name, that it is worth while to point out, in the first place, that the reference in "Index Kewensis" to "Cat. Plant. Hort. Parid., ed. iii, 136" is purely imaginary; yet many botanists copy this reference without ever looking it up. The citation reveals no maple of any sort. But in "Tableaux de l'école de botanique du Muséum d'histoire naturelle" Desfontaines in 1804 on page 136 characterized his *Acer tomentosum* as a woody ornamental of our southern states having "scarlet leaves." He says nothing more. A description that would fit any maple in the state would not satisfy any botanist who ever troubled to look up this citation.

615. **Acer saccharum** Marsh. (Sugar Maple)
A. saccharinum Wang. not L.

This fine tree occurs in the Canadian hemlock zone in the high mountain glens, and blooms in March and April. The individuals are usually rather scattered. Specimen: A big tree, Melrose, (leaves only) Sept. 12, 1921 (PT. no. 1498). In leaf form the above specimen corresponds exactly to *A. saccharum*, but the bark is a mealy white, almost like *A. leucoderme*.

Dr. Mackenzie has recently stated that *A. saccharum* as used by Marshall does not constitute an acceptable publication of a botanical name for the sugar maple. Dr. Mackenzie does not, however, suggest what would be the correct name. In searching among other names for the sugar maple numerous authors, amongst

them some writers on the trees of North Carolina, have fallen into the trap that is concealed by the name "*Acer barbatum* Michx." Michaux's original specimen is made up, as Fernald has shown, of sugar maple flowers and red maple fruits, and *Acer barbatum* is thus a chimerical species and should not be used by writers on our flora. I see no reason to displace Marshall's well-understood name.

616. **Acer saccharinum** L. (Silver Maple)
A. dasycarpum Ehrh.

There is a specimen of this in the Greene Herbarium, from Saluda, but no one else seems ever to have collected it from our area. While it is true that Greene occasionally included a cultivated specimen in his collections, I think the silver maple may be admitted, with some reservation, to the flora of this area. It is true also that this species is rare in North Carolina, there being more printed "reports" of it than actual specimens, but it is present in the state in a local way, and I am inclined to accept Greene's specimen as authentic, along with some of his other finds at Saluda which have not since been duplicated, such as *Populus grandidentata* and *Dirca palustris*. The hemlock zone at Saluda is just where such species are to be expected. The silver maple, a superb tree, blooms as early as January and not later than March.

617. **Acer Negundo** L. (Box Elder)
Negundo Negundo Karst.
Negundium fraxinifolium Raf.
Rulac Negundo Hitchc.
Negundo aceroides Moench.

This is a common tree of the lower stream courses, in the Congaree soils, growing with the sycamore, the river-bank birch, the alder, and the cane. Specimen: Along the Pacolet, (in fruit) Aug. 9, 1921 (PT. nos. 1125–1127). Blooms in March. The bark yields a red coloring matter used by country people.

Family 72. AESCULACEAE (Horse-chestnut Family)

618. **Aesculus octandra** Marsh. (Horse-chestnut. Sweet Buckeye)
Aesculus georgiana Sarg.

This handsome tree is common in our area especially on the northward-facing slopes of mountains, in the Porter soils, especially near streams. It is probably present on the piedmont also, in lesser quanti-

ties. Specimens: Melrose, May 1899 (Church.). Tryon Mt., May, 1918 (Millsp. no. 4027). There is also a specimen in the Greene Herbarium, from Saluda. Mr. W. W. Ashe writes me that near Melrose he noted *Aesculus georgiana*. This species as described by Sargent in "Trees and Shrubs" vol. 2, p. 259, does not differ in a single respect from *A. octandra* except in having pedicels and calyx without glandular hairs. Glandularity is at almost all times completely unstable from a taxonomic point of view, and this supposed species seems to me reducible to synonymy.

Family 73. IMPATIENTACEAE (Touch-me-not Family)

619. **Impatiens pallida** Nutt. (Jewel-weed. Touch-me-not)
Impatiens palustris Nutt
Impatiens montana Raf.

Common in muddy ground, around streams or in moist shady woods. Specimen: Rich soil, Melrose, Sept. 3, 1921 (PT. no. 1452).

620. **Impatiens biflora** Walt. (Jewelweed. Touch-me-not)
Impatiens fulva Nutt.
Impatiens maculata Muhl.

In the same habitats as the former, and like it yielding a yellow dye from the flowers, and having acrid-poisonous leaves. Specimen: Columbus, Aug. 1897 (Towns.).

Family 74. RHAMNACEAE (Buckthorn Family)

621. **Ceanothus americanus** L. (Red-root. New Jersey Tea)
Ceanothus officinalis Raf.
Ceanothus perennis Pursh

A common, pretty shrub of both piedmont and mountain woods, especially on hills. Specimens: Tryon Mt., June 1, 1899 (Towns.). Tryon, (in fruit), June 29, 1921 (PT. no. 784). Begins to bloom in early May. The leaves yield a tea-like infusion, the roots a red dye.

Family 75. VITACEAE (Grape Family)

622. **Parthenocissus quinquefolia** (L). Planch. (Virginia Creeper)
Hedera quinquefolia L.

Ampelopsis quinquefolia Michx.
Psedera quinquefolia Greene

This vine, superb in autumn and much cultivated, is common in our woods, especially in deciduous forests of the mountains and foothills. Flowers in May and June.

623. **Ampelopsis cordata** Michx. (Pepper Vine)
Cissus Ampelopsis Pursh

This plant is not generally found so far inland. It occurs, rarely, as a climber in thickets along the lower courses of the big streams. Specimen: Wet thickets along the Pacolet, near the Cleveland ("covered") bridge, (in fruit) Aug. 20, 1921 (PT. no. 1324).

624. **Vitis aestivalis** Michx. (Summer or Pigeon Grape)
Vitis bracteata LeConte
Vitis americana Bartram
Vitis sylvestris Bartram

Frequent in thickets. Specimen: Tryon Mt., May 31, 1899 (Towns). A pleasantly flavored species, fruit ripe in September, from which Norton's Virginia grape is a cultivated descendant.

625. **Vitis cordifolia** Michx. (Frost or Chicken Grape)
Vitis pullaria LeConte
Vitis Baileyana Munson

Common in thickets. Specimens: Lynn, May 1899 (Church.). Tryon Mt., May 31, 1899 (Towns.). Railroad embankment, Saluda, May 1918 (Millsp. no. 4152). The sour berries ripen after frost.

626. **Vitis vulpina** L. (River-bank or Frost Grape)
Vitis serotina Bartram
Vitis riparia Michx.

Common along streams, both in the mountains and on the piedmont. Specimens: Columbus, June 20, 1899 (Towns.). Saluda, May 1918 (Millsp. no. 4179). The acid but abundantly juicy fruits, ripening at time of frost, seem to have no important cultivated descendants but are good for making wild grape jellies.

627. **Vitis labrusca** L. (Fox Grape)
Vitis vulpina Bartram, not L.

Common by streams in thickets and forests throughout. Specimens: Tryon, May 1899 (Church.). Side of Tryon Mt., June 8, 1899 (Towns.). In low wet woods, "The Shoals," (leaves only) Aug. 20, 1921 (PT. no. 1328). Cultivated descendants of this are "Concord," "Isabella," "Niagara," "Diana," "Catawba," in fact most of the famous American table grapes. The wild fruits are variable, sometimes sweet, sometimes astringent, ripening in October.

628. **Vitis rotundifolia** Michx. (Muscadine or Bullace Grape)
Vitis vulpina T. & G., not L

Common along river banks of the piedmont and foothills, rare or absent from our mountains. Specimens: Columbus, June 16, 1899 (Towns.). Rich thickets, "Dark Corners," foot of Rocky Spur, (in fruit) Aug. 13, 1921 (PT. no. 1215). The fruits of this well-known species are as large as and similar in appearance to wild plums, are very handsome, ripen in early autumn and have a musky taste. Country people collect them to eat. An amber-fruited form has given rise to the famous scuppernong wine grape, for which our region is famous.

Family 76. TILIACEAE (Linden Family)

629. **Tilia venulosa** Sarg. (Linden. Basswood)
Tilia fulva Raf.

Frequent in cool mountain woods and glens. Specimens: Melrose, April 3, 1916 (Ashe). Melrose, July 4, 1917 (Harbison).

630. **Tilia Michauxii** Nutt. (Linden. Basswood)
Tilia heterophylla Vent. var. *Michauxii* Sarg.

Our commonest linden, frequent in the hemlock zone on the mountains. Specimen: Pearson's Falls, (leaves only) Sept. 12, 1921 (PT. no. 1497). From the same tree as the preceding citation, (fruits and bracts) May 30, 1927 (Wherry).

631. **Tilia eburnea** Ashe (Linden. Basswood)
T. lasioclada Sarg.

Occasional in rich soil in and near the mountains. Specimen: Near Tryon, June 25, 1897 (Bilt. Herb. no. 3751a).

632. **Tilia floridana** Small (Linden. Basswood)
Tilia alabamensis Ashe
Tilia crenoserrata Sarg.

Frequent in piedmont and foothill woods. Specimen: Polk Co., June 1895 (Ashe no. 102).

633. **Tilia australis** Small (Linden. Basswood)
Occasional in piedmont woods. Specimen: Rich woods, "Valhalla," (leaves and bracts) Aug. 25, 1921 (PT. no. 1388).

Family 77. MALVACEAE (Mallow Family)

634. **Sida spinosa** L.

An occasional tropical weed of cultivated grounds, farmyards, etc. Specimens: Columbus, 1899, without further data (Towns.) "Dark Corners," foot of Hogback Mt., Aug. 14, 1921 (PT. no. 1224).

In addition to the foregoing, the garden hollyhock (*Althaea rosea* Cav.) and the Rose-of-Sharon (*Hybiscus syriacus* L.) tend to persist around abandoned farms in a half-wild state. There are no native Malvaceae in our flora.

Family 78. GUTTIFERAE (Mangosteen Family)

635. **Ascyrum stans** Michx. (St. Peter's-wort)

Uncommon; confined chiefly to low sandy pine woods from Columbus eastward. Specimen: The "Huston Farm," near Columbus, Aug. 11, 1897. (Towns.).

636. **Ascyrum hypericoides** L. (St. Andrew's Cross)
Ascyrum multicaule Michx.

Common in dry woods, especially under pines. Specimens: Huston Farm, near Columbus, Aug. 7, 1897 (Towns.). Tryon, (in fruit) Dec. 17, 1918 (Day). Roadside, Melrose, Aug. 8, 1921, and Tryon, (in fruit) Oct. 1926 (PT. nos. 1109, 2377).

637. **Hypericum Buckleyi** (St. John's-wort)

Frequent in dry open soil or light woods, a splendid flowering shrub. This is an Appalachian endemic. Specimen: Tryon, July 19, 1921 (PT. no. 974).

638. **Hypericum punctatum** Lam. (St. John's-wort)
Hypericum maculatum Walt., not Crantz.
Hypericum corymbosum Muhl.

Common in woods or low ground. Specimens: Side of Tryon range, June 8, 1899 (Towns.). Tryon, (in fruit) Oct. 1926 (PT. no. 2395).

639. **Hypericum perforatum** L. (St. John's-wort)
A weed of European origin, somewhat naturalized in waste ground. Specimen: On the bank of the railway cut above Tryon, June 29, 1921 (PT. no. 781).

640. **Hypericum mutilum** L. (St. John's-wort)
Hypericum Crux-Andreae L.
Hypericum quinquinervium Walt.

Common in low muddy grounds, along streams and millponds, and on dripping rocks. Specimens: In low grounds, near the millpond, Tryon, July 23, 1921; in cold mountain springs, Shunkawawkin Falls, Tryon Mt., July 25, 1921 (creeping form); on dripping rocks, Melrose, Aug. 8, 1921 (PT. nos. 1056, 1020, 1117).

641. **Hypericum gentianoides** (L.) BSP. (Orange Grass. Pineweed)
Sarothra gentianoides L.
Hypericum setosum L.
Hypericum nudicaule Walt.
Sarothra hypericoides Nutt.
Hypericum Sarothra Michx.

Common as a little native weed in sandy fields of the piedmont. Specimen: Columbus, July 26, 1899 (Towns.).

Hypericum prolificum L. and *H. glomeratum* Small, both splendid flowering shrubs, have been collected just across the northern borders of our area, at Chimney Rock.

Family 79. CISTACEAE (Rock-rose Family)

642. **Lechea minor** L. (Pinweed)
Lechea thymifolia Michx.

Common in dry soils, chiefly on the micaceous schists and gneisses, among blueberries, pines, etc. Specimens: Dry meadows, Tryon, Aug. 11, 1921 (PT. no. 1178). Summit of Hogback Mt., (in fruit) Nov. 6, 1926 (PT. no. 2374).

Family 80. VIOLACEAE (Violet Family)

643. **Hybanthus concolor** (Forster) Spreng. (Green Violet)
Viola stricta Muhl.
Cubelia concolor Raf.
Solea stricta Spreng.
Ionidium concolor B. & H.

Rather frequent in rocky mountain woods, especially in deep shade and Porter's loam. Specimens: Gorge below the Upper Shunkawawkin Falls, May 13, 1897 (Towns.). Rich shady woods, Pearson's Falls (in fruit) Sept. 12, 1921; same locality, (in flower) May 11, 1926 (PT. nos. 1509, 1510, 2170). Pearson's Falls, April 12, 1928 (Kimber).

644. **Viola pedata** L. (Bird-foot Violet)
Viola multifida Mill.
Viola pedata var. *bicolor* Pursh; Raf.
Viola pedata var. *atropurpurea* DC.

Assuming the color form with the two upper petals dark purple, the three lower bright lilac to be the type of the species, we may say that the type is infrequent. The only specimens I have seen were from the Von Kahlden farm, foot of Tryon Mt., April 16, 1919, but doubtless they occur elsewhere.

Var. **lineariloba** DC.
Viola digitata Pursh
Viola inornata Greene
Viola pedata var. *concolor* Pursh.

This color phase, with all the petals lilac, is very common throughout our area in open sandy soil, and on sunny slopes. Specimens: Tryon, April 5, 1911 (Day; *fide* Brainerd). Little Warrior Mt., May 1918 (Millsp. no. 4047). Melrose Mt., April 20, 1922 (PT. nos. 1662). Forma *alba* (Thurber) House. Petals all white. Occasional. Specimen: Columbus, April 15, 1923 (PT. no. 1850; *fide* Brainerd). Forma

rosea (Sanders) House. Petals all roseate. A few plants were shown me on the Von Kahlden farm, April 26, 1919.

645. **Viola palmata** L. (Violet)

In deep rich woodlands. Specimens: "Skuyuka," White Oak Mt., April 1900 (Brainerd). Tryon, March 24, April 19, May 16, 1919 (Day; *fide* Brainerd). Tryon, April 20, 1922 (PT. no. 1673; *fide* Brainerd).

Viola palmata X *papilionacea* (*V. modica* House) is a hybrid collected at Tryon, April 15, 1900, by Brainerd. See *Bull. T. B. C.* **39:** 85, plates 5, 6; *Bull. Vt. Expt. Sta.* **239:** 155.

646. **Viola papilionacea** Pursh (Violet)

Common in moist meadows, woods, and near habitations. Specimens: Tryon, April 18, 1919 (Day; *fide* Brainerd). Tryon, April 19, 1922; Melrose, April 10, 1923; dry soil, Tryon, April 10, 1923 (PT. nos. 1657, 1825, 1839).

An albino form of this species is the so-called "Confederate violet" having grey-blue petals, much cultivated and sometimes escaped in our area. Specimen: Oct. 19, 1926 (PT. no. 2376). See Brainerd, Bull. Vt. Exp. Sta. **24:** 23. The following Latin names have been applied to this albino: *Viola obliqua* of Britton & Brown, ed. 1, *Viola domestica* Bicknell, and *Viola pratincola* Greene. I do not think it occurs in a native state in our area.

647. **Viola triloba** Schwein. (Violet)
Viola congener Leconte.

In dry woodlands, frequent. Specimens: White Oak Mt., May 25, 1899 (Towns.). Tryon, May 1899 (Church.). Tryon, April 18, 1919 (Day; *fide* Brainerd). Tryon, April 20, 1922 (PT. no. 1673).

Viola sororia X *triloba* (*V. populifolia* Greene) is a hybrid which Brainerd collected in April 1900.

648. **Viola sororia** Ait. (Violet)

Frequent in rich woods and along stream banks. Specimen: Tryon, April 16, 1922 (PT. no. 1615; *fide* Brainerd).

649. **Viola hirsutula** Brainerd. (Violet)
Viola villosa Nutt. not Walt.
Viola sororia Nutt. not Willd.

This, our smallest violet, is very characteristic of dry woods, under hickories, pines, etc., throughout, but especially the piedmont. Specimens: "Huston Farm" near Columbus, April 20, 1899 (Towns. Lynn, May 1899 (Church)). Tryon, April 16, May 16, 1919 (Day). It often begins to flower in March.

Viola hirsutula X *soroira* (*Viola perpera* House) is a hybrid collected April 16, 1909, by Brainerd. See *Bull. Vt. Exp. Sta.* **224:** 169; **239:** 125; *Bull T. B. C.* **27:** 176, plate 116.

650. **Viola affinis** LeConte (Violet)
? Viola obliqua Hill
? Viola cordata Walt.
Viola venustula Greene

Occasional in moist thickets. Specimen Tryon, March 23 and April 6, 1919 (Day).

Viola affinis X *palmata* (*V. discors* House) is a hybrid found by me on a red clay hill east of Millspring. Specimen: April 16, 1923 (PT. no. 1866).

Viola affinis X *triloba* is a hybrid collected by Brainerd in Tryon or near it. This was at first reported by Brainerd as "*V. emarginata*," but in a footnote on page 11 of Bull. **239** of the Vt. Exp. Sta. he decided it to have the parentage as shown above and says: "I would place here specimens I collected in Tryon April 17, 1909." See also Bull. Vt. Exp. Sta. **224:** 168.

651. **Viola Stoneana** House (Violet)
Viola septemloba Stone, not LeConte

Not infrequent, in moist woodlands. The range as given in Gray's "Manual" is incomplete, as it does not mention anything further south than Maryland. Specimen: Tryon, April 1911 (Day; *fide* Brainerd).

652. **Viola cucullata** Ait. (Violet)
Viola obliqua Schwein. not Ait.
Viola oconensis House

This is one of the commonest of our blue violets, in moist woods or

meadows. Specimens: Lower Shunkawawkin Falls, White Oak Mt., in moist deciduous woods, April 17, 1897 (Towns.). "Skuyuka," April 1900 (Brainerd). Tryon, March 24, 1919 (Day).

Viola cucullata X *fimbriatula* (*V. Porteriana* Pollard). This is a hybrid found on White Oak Mt. by Brainerd, who reports it fully in Rhodora **6**: 217. 1904.

653. **Viola fimbriatula** Sm. (Violet)
Viola ovata Mill.
Viola alleghaniensis R. & S.
Viola primulifolia Pursh not L.

Frequent, sandy fields, and dry hillsides. Specimens: South of Columbus, April 20, 1899 (Towns.). Skuyuka, White Oak Mt., April 1900 (Brainerd).

Viola fimbriatula X *palmata* (*V. convicta* House) is a hybrid found by Brainerd on Tryon Mt., April 1909. It is reported in Rhodora **15**: 114. 1910.

654. **Viola amorphophylla** Pollard (Violet)

As this species was originally described from, and solely from, specimens of our area, it may be as well to quote the original description. The author in Proc. Biol. Soc. Wash. **13**: 129, 1900, basing his species upon Bilt. Herb. specimens nos. 209, 214, May 5, 1897, from "Skuyuka," says: "Plant spreading in habit from a stout vertical rootstock, glabrous throughout and succulent; blades of the leaves elliptical or oblong elliptic, margins entire or obscurely crenate near the obtuse apex; base rounded or slightly tapering, rarely with small auricles or incisions; petioles mostly shorter than the blades; scapes surpassing the leaves; corolla purple, 2.5 cm. broad; sepals ovate-lanceolate; petals oblong, the short spur blunt; cleistogenes borne on erect peduncles."

Brainerd, and after him House, surmised (but did not apparently demonstrate) that this might be a hybrid, *V. cucullata* X *fimbriatula* (*V. Porteriana* Pollard); but Pollard considered it related to *Viola sagittata*. If a hybrid, this seems to me to be more like *V. cucullata* X *sagittata*, but I have here presented it as a valid species, believing it so to be.

655. **Viola sagittata** Ait. (Violet)
Viola dentata Pursh

Common in fields and on moist banks. Specimen: Tryon, May 14, 1919 (Day; specimen in fruit, this species flowering in March and April as well as May; *fide* Brainerd).

656. **Viola primulifolia** (White Violet)

Frequent in meadows and woods. Specimens: Tryon, May 1, 1911 (Day; *fide* Brainerd). Dry soil, Tryon, April 3, 1919 (PT. no. 055).

657. **Viola blanda** Willd. (White Violet)
Viola amoena LeConte

In rich shaded situations of Porter's loam. Specimens: Melrose, March 19, 1897 (Towns.). Bank of Vaughan's Creek, Tryon, April 14, 1919 (Day). In Bull. Vt. Exp. Sta. **224:** 81, Brainerd says of this that "on shaded rocks in Tryon, N.C., forms occur in which the upper surface of the leaf is quite glabrous."

658. **Viola pallens** (Banks) Brainerd (White Violet)
Viola blanda LeConte, not Willd.

In cool mountain woods, or moist meadows. Specimens: Skuyuka, Tryon Mt., May 1897 (Church.). Melrose, April 10, 1923 (PT. no. 1828; this specimen has the lateral petals beardless).

659. **Viola rotundifolia** Michx. (Yellow Violet)

In cool mossy mountain woods, rare. Specimens: Skuyuka Creek, Tryon Mt., March 24, 1897 (Towns.). Melrose Mt., April 17, 1911 (Fay). In rich cool woods, north side of Melrose Mt., April 1, 1919 (PT. no. 049).

660. **Viola hastata** Michx. (Yellow Violet)

One of our commonest species, often blooming in earliest spring. Specimens: South of Columbus, April 20, 1899 (Towns.). Tryon, March 11, 1911 (Day). Tryon, April 20, 1923 (PT. no. 1871).

661. **Viola eriocarpa** Schwein. (Yellow Violet)
Viola pubescens Ait.
Viola scabriuscula Schwein.
Viola gibbosa Raf.

Frequent in rich woods. Specimens: Melrose, April 20, 1922, and April 10, 1923 (PT. nos. 1663, 1824).

662. **Viola tripartita** Ell. (Violet)

There seems to be but the following collections of the southern species: Tryon, April 1909, 1910 (Brainerd nos. 173, 174).

663. **Viola canadensis** L. (Canada Violet)

A very common species in moist Porter's loam, under deep shade in the mountains and foothills. Though beginning to bloom in early April, it may sometimes be found in flower late in July by cold mountain springs, waterfalls, etc., its particolored flowers making it one of the most attractive of its genus. Specimens: Lynn, May 1897 (Church.). Side of Tryon range, May 1897 (Towns.). Tryon, April 21, 1911 (Day). Deep cool woods, Pearson's Falls, June 24, 1921, May 11, 1926; rich woods, "Valhalla," April 19, 1922; Melrose, April 20, 1923 (PT. nos. 667, 2158, 1653, 1826).

664. **Viola conspersa** Reichenb. (Violet)
Viola Muhlenbergii Torr.
Viola asarifolia Muhl.
Viola debilis Schwein.

Frequent in low mucky ground, in the Cecil clays of the piedmont. Specimen: Roadside ditches, "Valhalla," April 10, 1919 (PT. no. 075).

665. **Viola striata** Ait. (Violet)
Viola ochroleuca Schwein.
? Viola debilis Michx.

Frequent in moist soil, in the mountains, possibly present in low ground on the piedmont. Specimens: Lynn, May 1899 (Church.). Melrose, April 29, 1897 (Towns.). Pearson's Falls, April 20, 1922 (PT. no. 1684).

666. **Viola rostrata** Pursh (Long-spurred Violet)

This strikingly handsome species is rare, under deep shade on the Porter loams of the mountains. Specimen: Headwaters of the Saluda River, west side of Hogback Mt., May 1, 1919 (PT. no. 0561). It has

been reported to me from the north side of the Tryon range, and undoubtedly occurs in ravines in the unknown northwestern corner of the county.

667. **Viola Rafinesquii** Greene (Wild Pansy).
Viola tenella Muhl.
Viola bicolor Pursh

This, the only native species of the pansy section of the genus, is common as a little ruderal plant. Specimens: Roadside, Tryon, April 5, 1919 (Day; *fide* Brainerd). Railroad embankment, Melrose, April 10, 1923 (PT. no. 1827).

The sweet or English violet (*V. odorata* L.) and the pansy (*Viola tricolor* L.) are cultivated and half-naturalized. Though not absolutely our largest genus, it is very well represented for so small an area. Also the violets of our region have been rather carefully collected by Miss Day, Townsend and myself, and by good fortune our area was visited by America's foremost specialist in this genus, the late Dr. Ezra Brainerd. Inadvertently mention of his visits in 1900, 1909, 1910, was omitted from the historical introduction to this work. He collected and demonstrated the parentage of many hybrids in our area.

Family 81. PASSIFLORACEAE (Passion-flower Family)

668. **Passiflora incarnata** L. (Passion-flower. Maypop)

This splendid flower blooms from early June to August, and is common in open sunny ground on the Cecil soils. I do not think it occurs in the mountains in our area. Specimens: Columbus, June 18, 1899 (Towns.). Roadsides, June 20, 1921 (PT. no. 618).

669. **Passiflora lutea** L. (Passion-flower)

Much less conspicuous than the preceding in flower and fruit, prefering shade and the Porter soils. Specimens: At 2000 ft. altitude, in a rich glen, Melrose, Aug. 8, 1921; woods, Tryon, Aug. 25, 1921 (PT. nos. 1107, 1394; these specimens all in fruit).

Family 82. CACTACEAE (Cactus Family)

670. **Opuntia vulgaris** Mill. (Prickly-pear)
Cactus Opuntia L.
Opuntia Opuntia Coult.

Though common on sand of the Atlantic seaboard, this species, one of the few xerophytic plants of our area, is rare in western North Carolina. It selects in our area the dry gravel outwashes of the larger streams, and dry rock cliffs of gneiss on the south slopes of mountains. The fine golden flowers open but for a few days in May. Specimens: Poor's Ford, May 1900 (Towns.). Warrior Mt., May 1918 (Millsp. no. 4192). This is also found on cliffs near the summit of Tryon Peak, at about 3000 ft. altitude.

Family 83. THYMELEACEAE (Daphne Family)

671. **Dirca palustris** L. (Wicopy. Leatherwood)

It has been doubted that this northern shrub occurs in the southern states, but not only do Coker and House both list it from the mountains of our state, but there is an indubitable specimen of it from Tryon Mt. in the Greene Herbarium. It blooms in April and was used by Indians for thongs.

Family 84. LYTHRACEAE (Loosestrife Family)

672. **Lagerstroemia indica** L. (Crape-myrtle)

Introduced from Asia, much cultivated, and often naturalized or persisting in abandoned gardens. It blooms in July and August. There is a specimen from near Lynn in the Greene Herbarium.

Family 85. MELASTOMACEAE (Melastoma Family)

673. **Rhexia mariana** L. (Meadow Beauty. Deergrass)

A pretty little plant in alluvial ground of streams on the piedmont. It blooms in summer. Specimen: Near the bridge at Millspring, 1897 (Towns.).

674. **Rhexia virginica** L. (Meadow Beauty. Deergrass)

A very beautiful little species, found infrequently, in low wet ground in the eastern part of the county. Specimen: "The Shoals," southeast of Columbus, Aug. 20, 1921 (PT. nos. 1310, 1311).

Family 86. EPILOBIACEAE (Willow-herb Family)

675. **Ludwigia alternifolia** L. (Seedbox)
Ludwigia ramosissima Walt.

Ludwigia macrocarpa Michx.
Ludwigia aurantiaca Raf.
Isnardia alternifolia DC.

Frequent in roadside ditches, low alluvial ground, and shaded banks even in the mountains. The petals fall almost as soon as the flowers are picked. Specimens: Tryon, July 13, 1897 (Towns.). Melrose, Aug. 8, 1921 (PT. no. 1117).

676. **Epilobium coloratum** Muhl. (Willow-herb)
Epilobium tetragonum Pursh.

Frequent on wet or dripping rocks, under shade. Specimens: On wet rocks, "Dark Corners," foot of Hogback Mt., Aug. 13, 1921; on dripping rocks, Pearson's Falls, Sept. 12, 1921 (PT. nos. 1231, 1508).

677. **Oenothera biennis** L. (Common Evening Primrose)

A frequent native weed of fields and gardens. Specimen: Tryon, Nov. 3, 1926 (PT. no. 2386; though largely in fruit, part of this specimen was still in flower at this late date.) Summer and autumn.

678. **Oenothera laciniata** Hill (Evening Primrose)
Oenothera sinuata L.
Raimannia laciniata Rose

A common sprawling weed (native) of fields and gardens. Specimens May 5, 1911 (Tryon). Fallow fields, Tryon, May 5, 1926 (PT. no. 2134).

679. **Oenothera fruticosa** L. (Sundrops)
Kneiffia fruticosa Spach
Kneiffia tetragona (Roth) Pennell
Oenothera hybrida Michx.
Oenothera fruticosa var. *ambigua* Nutt.
Oenothera hybrida var. *ambigua* Blake
?Oenothera mollissima Walt.

The Latin nomenclature of this species at the present writing is in complete confusion, various views being taken by such modern botanists as Blake, Pennell, Bartlett and House. The present writer does not pretend to guess what name will eventually be decided on by taxono-

mists, and has hence used the name in the sense in which it is intended in Gray's Manual, ed. 7. This handsome diurnal species is one of our most characteristic flowers blooming from May to July, especially in mountain fields and woods. Specimens: Columbus, June 9, 1897 (Towns.). Tryon, June 29, 1921 (PT. no. 769). Melrose Peak, May 27, 1927 (Wherry).

680. **Oenothera glauca** Michx. (Sundrops)
Kneiffia glauca Spach

In cool mountain woods. An Appalachian endemic, rare. Specimen: Tryon Mt., June 4, 1919 (PT. no. 0284).

681. **Circaea latifolia** (Hill) Fernald (Enchanter's Nightshade)
Circaea lutetiana of auths. not L.

Common in mountain woods, on the Porter soils. Specimens: Side of Tryon Mt., June 21, 1899 (Towns.). Rich woods, Pearson's Falls, June 25, 1921, and (in fruit) Sept. 3, 1921 (PT. nos. 663, 664, 1446).

Family 87. NYSSACEAE (Tupelo Family)

682. **Nyssa sylvatica** Marsh. (Black Gum)

A common forest tree, especially in the mountains and on the slopes of foothills, but not unknown eastward. This is often called a tupelo in our region; this may not be actually incorrect, as there is no way of confining a common name to one botanical species, but that name is more precisely applied to *Nyssa aquatica* of the coastal swamps. Specimens: Skuyuka Creek, May 3, 1897 (Towns.). Tryon, May 6, 1926. "Skuyuka," (in fruit) July 21, 1921 (PT. nos. 2147, 1028).

Family 88. ARALIACEAE (Ginseng Family)

683. **Aralia racemosa** L. (Spikenard)

Common in cool mountain forests, in rich loam. Specimens: Vaughan's Gap, Rocky Spur, Aug. 14, 1921, and Hogback Mt., same date (PT. nos. 1212, 1213, 1244). These specimens were in fruit. The flowers bloom in July.

684. **Aralia spinosa** L. (Hercules Club)

Infrequent, in mountain woods. A curious small tree. Specimen: White Oak Mt., July 21, 1921 (PT. no. 1039).

685. **Hedera helix** L. (Ivy)

Much cultivated, introduced from Europe, and a rare escape. Specimen: At the foot of Lyncote Hill, June 20, 1921 (PT. no. 602,603). Flowers in early autumn; fruits in winter.

Panax quinquefolium L. (Ginseng) is said by country people to have been abundant in mountain woods at one time but now to be nearly extinct. I do not know who should know better than the country people, as it is they who for the ginseng trade have exterminated it—if it is really extinct in this area. I have searched for it in vain, and Townsend in his thorough work of years around Columbus did not find it, but I still think it may be found in the *Betula lutea* zone.

Family 89. UMBELLIFERAE (Parsley Family)

686. **Daucus Carota** L. (Wild Carrot. Queen Anne's Lace)

Common naturalized weed, of European origin, found in cultivated fields on the piedmont. May-Oct.

687. **Eryngium yuccifolium** Michx. (Button Snakeroot)
Eryngium aquaticum L.

Common, in dry woods and meadows throughout, but less frequent in the mountains. Specimen: Columbus, July 29, 1921 (PT. no. 1091).

688. **Sanicula gregaria** Bicknell (Bur Snakeroot)

Frequent in rich soil in the mountains. Specimen: Pearson's Falls, (in fruit) June 27, 1921 (PT. nos. 690, 691).

689. **Sanicula marilandica** L. (Bur Snakeroot)
Triclinum marilandicum Raf.

Common in dry woods and meadows, throughout. Specimens: Side of Tryon Mt., 1897 (Towns.). Tryon, May 1899 (Church.). Dry soil, Tryon, (in fruit) Aug. 11, 1921, and May 20, 1926 (PT. nos. 1191, 2206).

690. **Sanicula canadensis** L. (Bur Snakeroot)

Common in rich soil, or moist ground, throughout. Specimens:

Lower Shunkawawkin Falls, (in fruit) June 14, 1897 (Towns.). Tryon, May 1899 (Church.). Moist banks, "The Shoals," (in fruit) Aug. 20, 1921, and Pearson's Falls, in rich soil, (in flower) April 20, 1922 (PT. nos. 1339, 1683).

691. **Chaerophyllum procumbens** (L.) Crantz.
Scandix procumbens L.

Common native weed in cultivated grounds and by the roadsides. Specimens: Along the railroad track, Tryon, April 17, 1922, April 20, 1923 (PT. nos. 1652, 1872).

692. **Osmorhiza Claytoni** (Michx.) Clarke (Sweet Cicely. Wild Liquorice)
Myrrhis Claytoni Michx.
Scandix dulcis Muhl.
Osmorhiza dulcis Raf.
Osmorhiza brevistylis DC.
Urospermum Claytoni Nutt.
Washingtonia Claytoni Britton

This interesting and delicate plant, with edible roots, and aromatic bur-like fruits has so far been collected only in the shaded mountain loams at Pearson's Falls, but may well be more wide-spread. Specimens (in fruit): June 27, 1921, and May 17, 1926 (PT. nos. 697, 698, 2183). Flowers in early May.

693. **Cicuta Curtissii** Coult. & Rose (Water-hemlock)

A southern endemic closely related to the very poisonous spotted cowbane or musquash, *C. maculata* L. Frequent in mucky ground or water on the piedmont. Specimens (in fruit): Mill damn near Lynn, Aug. 20, 1921; sandy soil of the Pacolet alluvial plains, above Lynn, Aug. 29, 1921 (PT. nos. 1298, 1299, 1411).

694. **Cryptotaenia canadensis** (L.). DC. (Honewort)
Sison canadensis L.
Myrrhis canadensis Nutt.
Cyrtospermum trifoliatum Raf.
Deringa canadensis Ktze.

In the Porter stony loams, under shade, on the mountains, frequent. Specimens (in fruit): Side of Tryon Mt., June 22, 1897 (Towns.). Fields and thickets, Melrose, June 27; rocky woods, White Oak Mt., July 21, 1921 (PT. nos. 717, 718, 1031).

695. **Zizia Bebbii** (Coult. & Rose) Britton (Golden Alexanders)

Common in woods or open soil, throughout. Specimens cited before June are in flower, thereafter generally in fruit: "Skuyuka," May 1897 (Church.). Melrose, May 17, 1897 (Towns.). Pearson's Falls, June 27, 1921; Tryon, June 27, 1921; Tryon, July 19, 1921; White Oak Mt., July 25, 1921; state line, near Tryon, April 20, 1923 (PT. nos. 699, 700, 701, 976, 1076, 1869).

Miss Wright's list of Tryon plants includes *Zizia aurea*, K. Koch, but no one else has collected it. While possible, indeed even probable, that *Zizia aurea* occurs in this region, as it is found in Henderson County, it must also be admitted that she may have mistaken *Zizia Bebbii* for the older species. Hence it will not be formally included in this list.

696. **Zizia cordata** (Walt.) DC. (Golden Alexanders)
Smyrnium cordatum Walt.
Smyrnium trifoliatum Nutt.

Common in meadows and thin woods throughout. Specimens in spring are generally in flower, the later ones in fruit: Tryon Mt., June 1, 1897 (Towns.). Godshaw Hill, June 29, 1921; same habitat, April 16, 1922; Leitner meadows, May 20, 1926 (PT. nos. 773, 774, 1614, 2205).

697. **Taenidia integerrima** (L.) Drude. (Yellow Pimpernel)
Smyrnium integerrimum L.
Pimpinella integerrima Gray

In rocky mountain and foothill woods, occasional. Specimens: White Oak Mt., (in flower) May 8, 1897; Tryon Mt., (in fruit) June 1, 1899 (Towns.).

698. **Ligusticum canadense** (L.) Britton (Nondo. Angelico. Lovage)
Ferula canadensis L.
Ligusticum acutaefolium

Very common in woods and fields throughout, especially the piedmont. Specimens: Tryon, May 1899 (Church.). Spring Mt. Park, June 30,

1897 (Towns.). Woods and copses, Tryon, June 30, 1921; rich woods, "Dark Corners," Aug. 13, 1921; same habitat, Aug. 14, 1921; woods, Tryon, Aug. 23, 1921; in low swampy woods, "The Shoals," Aug. 20, 1921 (PT. nos. 815–817, 1263, 1356, 1340). Specimens cited after the month of July are not in flower.

699. **Thaspium aureum** Nutt. (Meadow Parsnip)

Occasional in shaded mountain woods. Specimens: Melrose, May 17, 1897; White Oak Mt., June 15, 1897 (Towns.).

700. **Thaspium barbinode** (Michx.) Nutt. (Meadow Parsnip)
Smyrnium barbinode Michx.

Not frequent; in shaded woods, especially the mountains. Specimens: Tryon, May 1897 (Church.). Side of Tryon Mt., June 17, 1897 (Towns.).

701. **Pastinaca sativa** L. (Parsnip)

Introduced from Europe, cultivated, and escaped. Specimen: In an alleyway, town of Saluda, June 30, 1921. Plant six feet high! (PT. nos. 800, 801).

702. **Angelica villosa** (Walt.) BSP. (Angelica)
Ferula villosa Walt.
Angelica hirsuta Muhl.

Very common; characteristic of the dry hickory woods, in summer. Specimens: Godshaw Hill, (in flower) July 18, 1921; dry woods, Tryon, Aug. 11, 1921; rich woods, Vaughan's Gap, Aug. 14, 1921; rich woods, Glen Walden, Aug. 24, 1921 (PT. nos. 977, 1177, 1260, 1369).

703. **Oxypolis rigidior** (L.) Coult. & Rose (Cowbane)
Sium rigidius L.
Oenanthe rigida Nutt.
Tiedemannia rigida Coult. & Rose

I believe this poisonous plant is present in its true form, but all the specimens I have seen seem to belong to var. *ambigua* (Nutt.) Robinson (var. *longifolia* Britton), with entire or remotely toothed, and broadly lanceolate, often brightly glaucous leaflets. Specimens: On dripping

rocks, Hogback Mt., Sept. 6, 1921, and Aug. 14, 1921 (PT. nos. 1472, 1249). It is also found behind Godshaw Hill, along rocks of Vaughan's Creek. The above specimens were in flower, with only immature fruit.

Family 90. CORNACEAE (Dogwood Family)

704. **Cornus alternifolia** L. f. (Cornel)
Cornus alterna Marsh
Svida alternifolia Small

Apparently found only in the Pacolet Gorge, on the north slope of Melrose Mt., deep shade, Porter's soil. Specimens: Along the railroad track below Melrose, May 5, 1897 (Towns.). Same habitat, April 24, 1919 (PT. no. 214).

705. **Cornus femina** Mill. (Cornel)
Cornus stricta Lam.
Cornus paniculata L'Her.
Cornus candidissima Marsh., not Mill.
Svida candidissima Small

Frequent as a shrub of low or marshy ground on the piedmont. Specimens: Erskine's millpond, July 23, 1921; along the Pacolet above Lynn, Aug. 20, 1921; Tryon, Aug. 17, 1921 (PT. nos. 1070, 1294, 1279.) All these specimens in fruit; flowers in April and May.

706. **Cornus Amomum** Mill. (Kinnikinnik)
Cornus sericea L
Cornus lanuginosa Michx.
Svida Amomum Small

A single specimen: Wet places, Lynn, June 9, 13, 1899 (Towns.). The leaf of this species was a form of Indian tobacco.

707. **Cynoxylon floridum** Raf. (Dogwood)
Cornus florida Raf.

There are few spots however small, and few habitats, where this splendid tree is not common. It flowers as early as the last week of March, and as late as the middle of May. The much-sought form with rose-colored bracts is rare, but the following specimen is an example. Columbus, April 15, 1923 (PT. no. 1845).

THE HABITS OF THE BLACK-NOSED DACE, RHINICHTHYS ATRONASUS (MITCHILL)[1]

By Jay R. Traver

Figures 1–4

Historical

Descriptions of the fish

This minnow was first described by Mitchill (1815), from the Walkill River, N. Y., as *Cyprinus atronasus*. Rafinesque (1817) describes it as *Cyprinus vittatus*, from "the Hudson above the falls." Storer (1839) reports it from Massachusetts, as *Leuciscus atronasus*, describing it somewhat at length. DeKay (1842) also describes it in detail, being the first to make note of the pharyngeal teeth. The genus *Rhinichthys* received its name from Agassiz (1850), who writes: "To this genus we must refer the *Leuciscus atronasus* (*Cyprinus atronasus Mitch.*)"

From that date to the present, many descriptions of the fish appear in the literature. These mention the prominent dark band which runs the entire length of the body, from the base of the caudal fin completely around the snout, passing through the eye, above which extends a parallel lighter line: the brownish-olive back and the silvery belly; the position, color and rays of the fins; the subterminal mouth; and the size, the fish attaining at the most 3 or (Fowler, '08) $3\frac{1}{2}$ inches in length. The difference in the colors of the sexes in the spring is first noted by Jordan and Gilbert (1882), previous writers having failed to mention that the orange fins and orange or red lateral band are worn only by the breeding males in late spring and early summer. Others refer to the very small scales, which give the fish a "sleek, glossy appearance" (Edwards, 1858); and to the great variation in coloring, which has led to the attempted establishment of many subspecies. Thus Jordan and Evermann (1896) say: "Excessively variable, running into several variaties, the extremes of which seem like distinct species." The black-nosed dace has been figured by several authors. Miss Edmonson's figure, in color from life, is most excellent.

[1] Contributions from the limnological laboratory, Cornell University.

Range and Habitat

Many records are to be found, also, of the localities from which the fish has been taken. Jordan and Evermann ('96) give its range as "New England to Minnesota, Northern Alabama, and Virginia." Its distribution, according to Forbes and Richardson, ('08) is somewhat greater: "Extends from New Brunswick and the rivers of northeastern Quebec through the Hudson and the Great Lakes to the James and the Roanoke, to the Dakotas in the northwest, and through the Ohio basin to Iowa and northern Alabama." It has also been found in western North Carolina (Jordan, '83).

From the earliest accounts of this species, its preference for rapid waters in small creeks has been an almost invariable accompaniment of other notes regarding it. It is associated, in literature, with the trout, the darters, the sculpins, the sticklebacks, the young of the black and common suckers, and such other minnows as the horned dace and the common shiner. "Clear, fresh-water streams and rivulets" (DeKay, 1842); "clear, cold rapid-flowing mountain streams" (Eggeling and Ehrenberg, '08); and "rapids or pools with strong current" (Greeley, '26), are typical expressions of its chosen habitat.

Habits

Its swift and active movements; its ability to escape a would-be captor; its prowess as a swimmer; and its lively and seemingly playful disposition, are attested by several writers. Abbott (1874) refers to the ease with which it escapes his scoop-net, "by burrowing under stones . . . . or else by leaping several inches from the water, and so passing over the rim of the net." Bean says, "swift and active in all its movements and beautiful in colors, it is one of the most interesting inhabitants of the water in which it lives." "If frightened, the fish will dart with lightning rapidity under stones, roots, or into other hiding places" (Eggeling and Ehrenberg, '08). Innes ('17) writes, "it is an extremely active swimmer and not easily caught unless cornered in a small pocket."

It makes a most desirable aquarium pet. "It is easily kept and tamed. I have some that are extremely tame, and who, when I tap on the glass, come to the side of the tank that I happen to be at, and, if I allow them, will nibble at my finger, ... readily take food from my hand, and seem to like being stroked gently" (Edwards, 1858). Mulertt writes, "When newly caught and placed in confinement, they should not be disturbed for some time, as they are easily frightened . . . . ."

"Several ought to be kept together, as it is playful and likes company, without which it will be less active" (Smith, 1902). Eggeling and Ehrenberg ('08), after noting its fondness for running water, say, "it is rather surprising how well it stands the sudden change to the aquarium, with its radically different conditions. . . . . While some of the fish may die during the first few days, the majority will survive and once acclimated, will probably live and thrive for years." Innes (1917) notes that it is "one of the best of our native fishes for aquarium purposes."

Food and Feeding Habits

Bean ('03) reports that Eugene Smith, keeping *R. atronasus* in the aquarium, "observed it to eat voraciously of animal food." Brüning ('04), also an aquarist, writes: "Die naturgemässe Nahrung für die Schwarznasen sind selbstverständlich Kleinkrebse und Insektenlarven, aber sie nehmen auch wie die Ellritzen totes Futter an und fressen Garnelenschrot und rohes Fleisch sehr gern." Kendall and Goldsborough ('08) find: "like the other dace, it feeds upon small aquatic animals and insects. Young individuals from about 1.29 to 1.66 inches long were found to be feeding upon diatoms, Entomostraca, small aquatic worms, and fragments of insects." Kendall (1918) adds, "it subsists mainly upon the aquatic larvae of insects and small insects that fall upon the water," also Entomostraca. Clemens (1917) found it feeding upon the swift-water mayfly *Chirotonetes*. Hankinson (1922) writes, "I found filamentous green algae the principal food in the intestines of seven of eleven of these fishes opened."

It remained for Breder and Crawford ('22) to make the first extensive study of the food of this minnow, examining 257 specimens taken by them from Oxon Run, D. C., during 1920. A tabular record of the food month by month is given, in volumetric percentages, followed by an analysis of the stomach contents, and a comparison of this fish with the five other minnows studied. They find insect remains 61%, vegetable remains 24%, and the remaining 15% "unidentified debris." "The vegetable remains were found to be almost exclusively in an unplasmolyzed state." They conclude from food eaten that "these fish feed more frequently from the bottom in the colder months." "All the insects, with a few prominent exceptions, were terrestrial species which evidently had fallen into the water." Unidentified insect remains amounted to 43%. They think the presence of diatoms and algae

purely accidental, taken in with insect food. In the aquarium, the fish took anything offered them, "provided it was the proper size, including such substances as boiled egg and shredded wheat, and fed "almost indifferently from either the bottom or the middle of the tank, and occasionally rose to the surface."

Further brief notes on its food are given by Greeley (1926, '28). He reports midge larvae as the most important item of food of 25 specimens examined, with lesser percentages of mayfly nymphs, caddis larvae and other aquatic larvae, and small quantities of algae and diatoms.

Reproduction

The breeding habits of a minnow he took to be *R. atronasus* are reported in detail by Gregg (1879), from Elmira, N. Y.: " . . . . a nest of the fish was discovered in the stream below, it was about two feet in diameter, situated in running water from twelve to fifteen inches deep, and protected from the upper side by a small root by which the current of the water was broken. The female would pass over the pebbles and deposit her spawn, while the male stood ready for an attack, and on the approach of an enemy would dart off like a flash in pursuit of the intruder. When no danger was near, and after the bed had been covered with spawn, the female would stand sentry until the male had passed over the eggs, and then both would proceed up the stream from four to ten feet or more, and taking a small pebble in their mouths, would quickly return and deposit them on the fecundated eggs, sometimes but one fish would go for pebbles, the other lingering near, thus layer after layer of impregnated eggs and pebbles were deposited one upon the other."

Another account of the spawning of "the dace (*Rhynichthys abronasus*)" is given by Holder (1883). "In the warm weeks of June come the sterner duties, the nesting time; male and female join in the preparation, and the locality is selected, perhaps in some running brook, in shallow water. Roots, snags, and leaves are carried away, both sometimes tugging at a single piece, taking it downstream, and working faithfully, until we, who are watching from the bank . . . . see a clearing over two feet in diameter. Here the first eggs are deposited, and the male, who has retired, soon appears from upstream, bearing in its mouth a pebble, that is placed among the eggs that form a layer in the center of the clearing. Now they both swim away, soon returning, each bearing

a pebble in its mouth, that is dropped upon the eggs. Slowly the work goes on, until a layer of clean pebbles apparently covers the eggs. Now the female deposits a second layer of eggs, and more pebbles are brought, the little workers scouring the neighborhood for them, piling up eggs and pebbles alternately, until the heap attains a height of eight inches or more, formed in various shapes, sometimes pyramidal or dome-shaped —monuments of the patience of these finny housekeepers."

Other notes on its breeding habits are brief. Abbott ('84) quotes from Holder (see above). Gill (1907) writes, "They prepare a nest of stones for the reception of the eggs, which is taken charge of by the male." Later in the same year, in another article, he speaks of Gregg as being the first to communicate a "detailed notice of a stone-gathering cyprinid." Forbes and Richardson ('08) report: "It has been seen to spawn in shallow running water, piling pebbles up about the nest after the eggs are deposited." The spawning time—late spring and early summer—is mentioned by Fowler and by Kendall and Goldsborough, both writing in 1908. Reighard, 1910, observed it spawning in an aquarium.

Parasites

In 1908, Fowler says, "The fish is often found greatly parasitized with tapeworms, the abdomen then being greatly swollen." Innes ('17) speaks of its being "quite subject to a parasite which embeds itself deeply in the sides of the fish, producing an appearance best described as looking like 'fly-specks'." He does not think this injures the fish to any extent. Kendall ('18), in giving a list of common names applied to the fish, says the terms pot belly and pottle belly "are derived from the frequently distended appearance of the abdomen due to tapeworms, with which the fish seems to be extensively affected." Breder and Crawford ('22) find this species "heavily infested with intestinal parasites"—22 out of 257 specimens containing these worms. The fish seemed to show no ill effects from their presence, being "uniformly fat and healthy in appearance."

Economic importance

Kendall ('13) indicates that "it affords food for trout to some extent, but in the brooks it occupies the warmer portions in summer, where the trout are not at that time found." Breder and Crawford suggests its introduction into streams that are suitable for trout, but lacking in

native food, with the idea that the trout will feed upon it. Greeley ('26) points out two sides to this problem. He writes: "Little is known upon the subject of minnows and their relation to trout. It is known, however, that trout eat some minnows and other fishes." A brown trout taken by him had eaten "a young sucker and a black-nosed dace. These made 40% of the food of this individual." Later in the same paper he shows from examinations of the stomachs of these two species of fish, that the dace "compete with the trout for food." Mention of its use as bait is made by several writers. Kendall and Goldsborough suggest that it makes "attractive bait for salmon and trout."

LOCAL HABITAT; BEHAVIOR; PARASITES; ASSOCIATES

The fishes for this study have been taken from that portion of Cascadilla Creek above the falls which forms the southern boundary of the campus of Cornell University, Ithaca, N. Y. In this part of its course the creek is rapid-flowing, passing over a bed of rocks and pebbles, its waters at no point very deep. The overhanging grassy banks and rock ledges afford shelter for the larger dace, while the flat stones in the bed of the stream serve as hiding places for the smaller ones. Clemens ('17) finds that the oxygen content of the water in this stream is high throughout the year, the carbon dioxide content low: both of these conditions he attributes to the "turbulent nature of the creek." The water temperature, fluctuating with the air temperature, "never reaches the extremes of the latter," 28°C. being the maximum, 0°C. the minimum, which he records. He finds the pollution not excessive.

In collecting black-nosed dace from this creek and elsewhere, the agility of the fish in eluding the net, its tendency to escape by jumping, and its quickness in hiding beneath stones or other shelter when frightened, have been found most characteristic. Complete success in catching these minnows with a net has not been attained, but several methods have yielded fair results. Often the larger dace may be taken by holding the net close to the bank in deep water, and beating above it with a stick. Or, if the net is held motionless in a runway of the fish until a school of them return downstream, several may be taken though the larger ones are very wary of such a trap. The slightest movement sends the whole school scurrying to shelter, or up or down the stream for some distance; but they soon return one by one, and if not further alarmed will presently resume their normal activities. In rapid water it is difficult to see them, so completely are they protected by their

coloring when in their native environment. In the aquarium the younger dace soon become quite tame, as has been noted by many writers, but the larger ones remain for a long time shy and distrustful. Mayfly and stonefly nymphs, Chironomid larvae, finely-cut liver and sections of live earthworm are accepted by them as food, although the natural foods prepared for goldfish will serve as well. They feed from any part of the tank with equal ease, and are often seen to scoop up a mouthful of sediment from the bottom, but usually seem to find this unappetizing, ejecting it almost immediately.

Parasitic nematode worms were found in the alimentary canals of 26 of the 248 fishes examined. Eight worms being the greatest number recorded from any one fish (Nov. 9, '18,—fish 37 mm. long). The fish so parasitized appeared entirely normal, and no swelling of the abdomen or other external sign gave evidence of the presence of the parasites. Several dace with much-swollen abdomens were taken, but no parasites were found on opening them,—only an unusually heavy meal. Thus, one 24 mm. dace, its abdomen much swollen, contained 11 Chironomid larvae, 7 mayfly and 3 stonefly nymphs. Attached to all parts of the body of the dace externally were found other encysted parasites, sometimes so numerous as to give the fish a freckled appearance. Like the internal parasites, these seemed to do the host fish no particular harm.

In summer the waters of Cascadilla Creek become quite shallow and warm, but dace of all sizes are still plentiful there, the larger ones in the deeper pools, the very young ones over the shoals. In winter all are found close up under the banks, in the deepest water available. In company with the black-nosed dace in this portion of the creek are such other species of fishes as the horned dace (*Semotilus atromaculatus*), the young of the white sucker (*Catostomus commersonii*), the common shiner (*Notropis cornutus*), and the Johnny darter (*Boleosoma nigrum*). The black-nosed dace is known to be a member of the brook and rainbow trout association in many streams, in company with the sculpin. Coker ('25) believes that the hydrogen-ion concentration may be an important factor in restricting this type of association. Greeley ('28) states, "the warmer the stream, the more species of fish are present," and uses Fall Creek, which is near Cascadilla Creek and quite similar to it, as an illustration. At least it appears to be certain that the black-nosed dace may be a member of two different fish associations, one in cold and one in warm waters, though more than one factor may be responsible for its presence there. It is equally certain that this fish does not occur in the warmest waters even of the smaller streams, which it normally

inhabits, nor is it found in deep, quiet ponds which may be a part of the course of such a stream. Thus, in Dwyer's pond, a stretch of deep, relatively quiet water just below the region where the fish were collected, no black-nosed dace are found, but other species present are: the white sucker, the bullhead (*Ameiurus nebulosus*), the rock bass (*Ambloplites rupestris*), the Cayuga minnow (*Notropis bifrenatus*), the golden shiner (*Notemigonus crysoleucas*), and the pike (*Esox lucius*). Dr. A. H. Wright says that all of the fish mentioned above as taken from Cascadilla Creek, with the exceptions of the brook trout, the black-nosed dace, the horned dace, perhaps the bullhead, and the white sucker, were introduced into this stream some years ago from below the falls.

In addition to the fish fauna mentioned, Cascadilla Creek supports a great variety of the smaller forms of life, many of which make suitable food for the dace. Such larval insect forms as the mayfly nymphs *Chirotenetes, Leptophlebia, Baetis* and *Heptagenia;* the stoneflies, *Perla, Perlinella, Capnia, Acroneuria,* and *Taeniopteryx;* the caddisflies, *Hydropsyche* and *Goera;* the dipterous larvae, *Tipula* and *Chironomus;* the coleopterous larvae, *Haliplus, Psephenus* and *Hydrophilus;* and occasionally the hemipterous nymph, *Corixa,* were taken from this portion of the stream rather commonly throughout the year. Various kinds of algae are present there, with a rich growth of diatoms on the rocks at certain seasons. An occasional dusky or two-lined salamander (*Desmognathus fuscus* and *Eurycea bislineata*) adds to the list of vertebrate inhabitants of the creek.

Food and Feeding Habits

Methods

The fishes used for the study of food were collected on 20 different dates (see Tables I and II), from September 1918 to August 1919, inclusive. They were killed in 7% formalin. Each fish was then tagged with a number and preserved for further study. A record of the number given each fish, the date of its capture, and its live weight and length was carefully kept, and to this was added a record of the contents of the alimentary canal. To obtain the latter, the alimentary canal was removed and opened, the entire contents placed in a watch glass with a small amount of water, the different items of food isolated, and the percentages of each item estimated. Pearse's method of considering the entire contents of each alimentary canal as unity was followed, and percentages of different foods were made on this assumption. When

possible, as in the case of insects, the number of specimens of each type of food eaten was added, and identification of food materials to genus, and occasionally to species, followed. In some instances, identification could be carried no further than to families. Insects were often represented only by their chitinized parts, as portions of legs, heads or jaws; yet many Chironomid larvae were found almost intact. Difficulty was sometimes met in separating masses of diatoms from the algae tangled among them; in such cases, the entire mass was listed as diatoms, if these predominated. Algae mentioned in the table were present in masses comparatively free from diatoms.

By the term "young fishes" is meant those which are probably in their first year. Estimates of the approximate size-limit of first-year fishes at different seasons have been made by means of length-weight curves (see Age Determination). Thus, 33 mm. is assumed to be the size-limit at the end of the first autumn. 42 mm. the size-limit for fishes in the spring of their first year. Since the fry of each season are feeding by the first of July, the approximate diet of a dace from Cascadilla Creek during its first year of life may be determined from table I by beginning with the collection of July 7, thence reading through the summer and autumn, returning to the collection of Jan. 21, 1st column, and continuing through the months of early and late spring. "Older fish" are all which have attained a length of more than 33 mm. in the autumn, and of more than 42 mm. in spring and summer. In both tables a + sign indicates less than 0.5% of the item under consideration. 0.5% and above has been expressed as the next whole number. All averages have been reduced to whole numbers, hence some slight inconsistencies may appear. The ten young dace taken on June 3 were from Bear Creek, near Freeville, N. Y. All others were taken from Cascadilla Creek.

One fish had taken an earthworm, which fact does not appear in the tables. Dipterous larvae other than Chironomidae were *Tipula*, *Antocha*, *Culex*, *Ceratapogon* and a muscoid fly. Mayfly nymphs were *Baetis*, *Chirotenetes*, and *Blasturus*, while one fish had taken an adult *Callibaetis*. Hemipterous nymphs were *Corixa;* the adults, Jassidae and Aphididae. An Ichneumon and Cynipid were the adult Hymenoptera. Crustacea included the cladocerans, *Bosmina* and *Simocephalus*, and such other forms as *Cyclops*, *Asellus*, *Hyalella* and *Canthocamptus*, also several nauplii. Algae were represented by *Ulothrix*, *Draparnaldia*, *Cladophora*, *Chaetophora*, *Mougeotis*, *Tribonema*, *Microspora*, *Zygnema* and *Oscillatoria*. The commonest diatoms were *Diatoma*, *Navicula*, *Cymbella*, *Synedra*, *Meridion*, *Tabellaria*, *Gomphonema*, *Fragillaria*, *Surirella* and *Melosira*, while the desmid *Closterium* appeared several times.

Discussion of food.

1. Young fishes. Chironomid larvae formed the principal article of diet of the 191 young fishes, making up 42% of the entire food. Mayfly nymphs, 15%, were next in importance, the total insect food amounting

TABLE I

Contents of Alimentary Canal—Young Fishes

	DATE TAKEN																				TOTALS
	January 21	January 22	March 4	March 12	March 20	April 17	May 8	May 21	May 27	May 29	May 30	June 2	June 3	July 7	August 2	August 16	September 1	October 28	November 9	November 13	
Number examined	2	0	21	5	3	3	4	3	2	0	2	4	10	39	45	10	8	3	26	1	191
Average length (mm.)	25.3	....	32.0	33.6	33.6	35.0	36.8	35.0	31.5	....	35.5	36.0	29.0	17.5	20.0	22.3	25.2	29.5	29.3	28.0	.....
Average weight (gm.)	0.12	....	0.49	0.58	0.53	0.75	0.81	0.73	0.55	....	0.71	0.65	0.39	0.089	0.164	0.205	0.30	0.33	0.295	0.25	.....
Maximum length (mm.)	26.3	....	37.0	38.0	39.0	38.0	37.3	38.3	32.0	....	40.0	37.3	36.0	24.0	30.0	27.0	28.0	33.3	33.3	....	.....
Minimum length (mm.)	24.3	....	25.0	26.0	29.0	31.0	36.3	35.3	31.0	....	31.0	34.3	23.0	14.0	13.0	16.0	22.0	27.0	21.3	....	.....
Maximum weight (gm.)	0.15	....	0.83	0.83	0.80	1.0	0.83	0.90	0.60	....	1.0	0.70	0.70	0.23	0.50	0.40	0.40	0.55	0.50	....	.....
Minimum weight (gm.)	0.10	....	0.23	0.23	0.30	0.53	0.80	0.60	50	....	0.43	0.60	0.20	0.03	0.06	0.10	0.20	0.20	0.125	....	.....
																					AVERAGES
Ephemerida—nymphs	....	....	13	19	15	61	45	17	....	....	....	15	25	8	2	....	8	25	5	....	15
Plecoptera—nymphs	....	....	2	....	20	....	....	....	....	....	....	....	....	....	+	....	....	11	3	....	2
Trichoptera—larvae	....	....	+	....	....	13	....	....	....	....	....	....	2	....	....	....	....	....	....	....	1
Diptera—Chironomid larvae	....	....	84	81	63	15	32	42	6	....	29	5	51	38	48	59	61	43	34	10	42
Diptera—larvae (others)	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	3	....	....	....	+
Unidentified insect larvae	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	3	....	2	....	+
Trichoptera—pupae	....	....	....	....	....	....	....	....	....	....	22	....	....	....	....	....	....	....	....	....	1
Diptera—Chironomid pupae	....	....	....	....	....	7	....	....	....	....	....	....	....	1	4	10	4	....	....	....	2
Hemiptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	6	3	....	....	....	....	....	1
Diptera—Chironomid adults	....	....	....	....	....	....	9	34	....	....	8	....	....	1	....	....	....	....	4	....	3
Coleoptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0
Hymenoptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	+
Insect eggs (unidentified)	....	....	....	....	....	....	4	....	....	....	....	....	....	....	1	....	....	....	....	....	+
Total Insect Materials	....	....	99	100	98	96	90	93	6	....	59	20	78	58	59	69	79	79	48	10	67

Arachnida	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	.....	.....	.....	.....	....	+
Rotifera	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	2	.....	.....	.....	.....	.....	+
Small Crustacea	....	....	....	....	....	....	....	....	....	....	....	....	....	7	.....	.....	2	...	7	5	1
Nematode worms	....	....	1	....	2	3	10	....	....	....	....	8	....	1	1	.....	.....	8	2	....	2
Total Animal Materials	....	....	100	100	100	99	100	93	6	....	59	28	78	67	63	69	81	87	57	15	70
Diatoms	....	....	....	....	....	....	....	....	94	....	37	72	18	7	12	25	11	....	34	....	18
Filamentous algae	....	....	....	....	....	1	....	....	....	....	4	+	+	3	12	2	5	....	+	....	2
Higher plants (tissues)	....	....	....	....	....	....	....	....	....	....	....	....	1	5	4	2	1	5	1	25	3
Total Plant Materials	....	....	....	....	....	1	....	....	94	....	41	72	19	15	28	29	17	5	35	25	23
Debris	....	....	....	....	....	....	....	7	....	....	....	....	3	18	9	2	2	8	8	60	7
Number fish found empty	2	....	....	....	....	....	1	....	....	....	....	....	....	5	1	.....	.....	.....	.....	.....	9

TABLE II

Contents of Alimentary Canal—Older Fishes

	DATE TAKEN																				TOTALS
	January 21	January 22	March 4	March 12	March 20	April 17	May 8	May 21	May 27	May 29	May 30	June 2	June 3	July 7	August 2	August 16	September 1	October 28	November 9	November 13	
Number examined	1	1	0	0	1	1	0	1	0	15	0	0	0	1	3	9	4	7	12	1	57
Average length (mm.)	36.5	37.3	....	....	44.0	52.0	....	51.0	....	56.8	....	....	....	45.0	45.0	52.0	46.2	51.5	47.7	35.0	.....
Average weight (gm.)	0.7	0.8	....	....	1.4	2.4	....	2.4	....	3.2	....	....	....	1.5	2.5	1.72	1.74	2.5	2.0	0.6	.....
Maximum length (mm.)	....	....	....	....	....	....	....	....	....	63	....	....	....	....	60	53	54	61	58	....	.....
Minimum length (mm.)	....	....	....	....	....	....	....	....	....	47	....	....	....	....	38	40	40	36	37	....	.....
Maximum weight (gm.)	....	....	....	....	....	....	....	....	....	4.7	....	....	....	....	3.5	2.9	2.6	4.2	3.5	....	.....
Minimum weight (gm.)	....	....	....	....	....	....	....	....	....	2.1	....	....	....	....	0.9	1.1	1.1	0.7	0.7	....	.....
																					AVERAGES
Ephemerida—nymphs	....	50	....	....	50	40	....	62	....	50	....	....	....	....	2	4	....	2	14	....	21
Plecoptera—nymphs	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8	3	7	....	1
Trichoptera—larvae	....	....	....	....	....	....	....	....	....	7	....	....	....	....	....	2	8	1	....	....	1
Diptera—Chironomid larvae	95	....	....	....	50	15	....	13	....	1	....	....	....	47	15	7	....	3	1	....	19
Diptera—larvae (others)	....	....	....	....	....	5	....	....	....	....	....	....	....	....	....	....	3	1	....	....	1
Unidentified insect larvae	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	....	....	....	....	+
Trichoptera—pupae	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0
Diptera—Chironomid pupae	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	+
Hemiptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8	....	....	1
Diptera—Chironomid adults	....	....	....	....	....	....	....	....	....	....	....	....	....	6	....	....	16	....	....	....	3
Coleoptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	....	....	....	+
Hymenoptera—adults	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0
Insect eggs (unidentified)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	+
Total Insect Materials	95	50	....	....	100	60	....	75	....	58	....	....	....	53	17	17	42	19	22	....	47

Arachnida	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	+
Rotifera	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	+
Small Crustacea	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	+
Nematode worms	....	....	....	....	....	40	....	....	....	6	....	....	....	....	....	2	4	....	11	....	5
Total Animal Materials	95	50	....	....	100	100	....	75	....	64	....	....	....	53	17	19	46	19	33	0	52
Diatoms	....	....	....	....	....	....	....	....	....	6	....	....	....	....	57	58	29	75	59	100	29
Filamentous algae	5	....	....	....	....	....	....	....	....	+	....	....	....	....	10	17	23	5	7	....	5
Higher plants (tissues)	....	....	....	....	....	....	....	....	....	9	....	....	....	....	16	1	2	1	1	....	2
Total Plant Materials	5	0	....	....	0	0	....	0	....	15	....	....	....	0	83	76	54	81	67	100	36
Debris	....	50	....	....	....	....	....	25	....	21	....	....	....	47	....	5	....	....	....	....	12
Number fish found empty	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	1	....	....	....	2

to 67%. Nematode worms to the amount of 2% were present, and 1% of small Crustacea, giving 70% as the total animal material present. Debris amounted to 7%, the remaining 23% being plant materials, diatoms predominating as 18% of this. Nine fishes were empty.

2. Older fishes. The food of the 57 older fishes differed in certain respects. Thus, Chironomid larvae formed but 19%, mayflies being the principal insect food, 21%. The total insect food was 47%, total animal materials present, 52%; nematode worms made up the additional 5%, with Crustacea forming less than 0.5%. Plant materials formed 36% of the total food of these fishes, 29% of which was diatoms, 5% filamentous algae. Only two of the older fishes were empty.

3. Comparisons. Black-nosed dace during their first year of life feed largely upon the larvae of aquatic insects, principally Chironomid larvae. Pupae and adults of other insects, some aquatic and others terrestrial (Hymenoptera and Hemiptera) are present in small amounts. Small Crustacea are taken sparingly during the first summer and autumn. Diatoms are the most important plant food. Older dace take a larger percentage of plant food than the young, principally diatoms, though animal food still predominates. Mayflies are now preferred among the aquatic insect forms, though Chironomid larvae run a close second. Terrestrial forms are taken as before. Crustacea are rarely taken, internal parasites are more numerous. The percentage of fish found empty is somewhat less, and those taken during the winter had been feeding, which was not true of the young taken at that time.

4. References. Forbes (1880) was the first to note that the "food of many fishes differs greatly according to age," often corresponding to the changes in their feeding structures. He insists, too, (1888), "that fish are not mere animated eating-machines—but that psychological preferences as well as physical capabilities have something to do with their choice of food." Pearse (1915) shows that while some small fishes change their type of food as they grow, others always have the same diet; that some eat the same food in all habitats, while others vary their food "with a change in environment." In 1915–16 he writes: "All things, then, indicate that fishes select food from their environment." Breder and Crawford (1922), however, from their work on the food of dace, feel that any food of proper size is acceptable to the fish, its ingestion depending entirely upon its physical properties.

5. Conclusions. As is to be expected from the nature of the pharyngeal teeth and the short intestine, this fish is in the main insectivorous. The work reported above, on the food of the dace in Cascadilla Creek,

seems to indicate (1) that the feeding habits of this minnow do not change markedly with increase in size; (2) that young dace during July and August of their first year have a wider range of diet than at any other time in their lives; (3) that the items included in their food for these first two months are taken from all regions of the stream, but that food from the top and middle regions reaches its highest percentage at this time; (4) that this fact (see 3) corresponds well with the observations made on young dace during these months, which showed them to be feeding largely near the surface; (5) that crustaceans and rotifers form a small percentage of the food of young dace during their first summer and autumn, but are negligible as items of food thereafter; (6) that the greatest variety of foods in both young and old corresponds with the season of greatest wealth of food organisms in the stream; (7) that Chironomid larvae and pupae, and mayfly nymphs, are preferred by both young and old dace to all other aquatic insect forms, the former making up 42% of the food of all the young dace, while older dace show a slight perference for the latter; (9) that stoneflies and caddisflies, while almost as abundant in the stream as mayflies and presumably as easy for the fish to catch, formed but a very small percentage of the food of dace of all ages; (10) that plant materials form a somewhat larger percentage of the food of older fishes than of the young, diatoms being the most important item in this group; (11) that since the cold-weather food of dace of all ages is mainly aquatic insect larvae, the fish feed more from the bottom during this period; and (12) that it appears that these fish do exercise a certain amount of choice in their selection of food, although dependent upon the seasons for items from which to select. No conclusions can be drawn from the recorded fact that many fishes were empty when taken. The greater amount of debris in the older fish may be due to their feeding more largely from the bottom of the stream, though by no means do they confine themselves to this region for food-taking.

6. Comparisons with work of Breder and Crawford. Differences noted in Tables I and II of this paper, and the table given by Breder and Crawford for the food of the 257 dace examined by them, may be explained in part as follows: (a) averages given by them are for dace of all sizes, not for young and old separately; (b) the fish they used were collected from a very different locality, much further south than the one discussed in this paper; (c) their tables are evidently for food alone, not enteric contents, as parasitic worms are given no place therein; and (d) the large percentage of unidentified insect remains in their table corre-

sponds quite closely to the item, Chironomid larvae, in the tables given here, suggesting the possibility that the two might be identical. The conclusions reached by them regarding all plant materials as purely accidental, does not seem to the present writer as sufficiently supported by the facts they give, nor does it seem to correspond to the facts shown in Tables I and II of this paper. Aside from minor differences, however, there is a marked and interesting similarity between their results and the results obtained by using fishes taken from Cascadilla Creek.

REPRODUCTION

Breeding habits

In the spring of 1919, observations were made on the spawning habits of the black-nosed dace in Cascadilla Creek. Two females captures on May 8th had begun to show a distention of the abdomen, and were placed in an aquarium with two bright-colored males in the hope that they might spawn. As they gave no evidence of spawning, they were stripped on May 19th, the eggs appearing to be not yet ripe. On May 29th, many adult dace were seen in a branch of the creek, and the following day a school of brilliantly colored males was swimming about above a little sandbar in the same part of the stream. No females were seen with the males, but many were captured from under flat rocks further down the branch stream, near the main part of the creek. A moderate current was flowing through this branch of the creek, but the water was quite shallow in most places. The bed of the stream was composed mainly of rocks and pebbles, over which the water flowed in a series of shallow riffles. About halfway up the branch stream was a quiet pool, partly encircling the roots of a tree. The water entering from above had a fall of two or three inches into this pool, forming a sandbar above which the school of male dace was observed. The water at this point was five inches in depth. These males were busily fanning the gravel with their fins and tails or upturning it with their snouts, many of them working side by side with heads upstream. If any nests were excavated here, the action of the water and the movements of the other fish quickly obliterated all signs of them.

The temperature of the water on May 31st was 72°F., on which date schools of male and female dace were seen in the shallows. The first spawning was observed on June 2nd, the day being fair and warm, and the water in the creek fully an inch lower than on May 30th. Many males were observed in the riffles, jumping out of the water at intervals,

and wriggling between the stones. In many places the water was barely deep enough to cover the bodies of the fish, so that they often experienced great difficulty in swimming. When frightened, they swam upstream into deeper water, hiding beneath stones and under the edges of the bank, but returned one by one, and in about twenty minutes all were back in the riffles. Henceforth they paid little heed to slow movements of the observer, so that they could be studied at a distance of less than two feet. Both males and females were now seen, some coming up from the lower part of the stream, others from hiding places in the deeper water above. Several males were often seen accompanying one female. Many of the females were larger than the majority of the males, and a small male would be seen swimming with a female much larger than himself. The sandbar about which the males had congregated a few days before seemed now to hold no attractions, as all the fishes turned toward the riffles, heads upstream.

A male and female dace appear close at hand. If the water is deep enough to permit it, the males swims back and forth six or seven times beneath the body of the female, occasionally passing over or in front of her. If the water is too shallow for this, he darts back and forth in front of her several times, as a preliminary to the act of spawning. Suddenly he comes close to her side, presses his head and the fore part of his body close against hers, throws his tail over her body, meantime setting his body into rapid vibration and spashing with his tail in the water on the opposite side of the female. The vent of the male is thus above the vent of the female, and somewhat to one side. The female in the meantime holds her body normally, and apparently without vibration (see Fig. I). The splashing of the male continues a second or two, the vibrations of his body perhaps aiding the female in extruding the eggs. Then the vibrations and the splashing cease, and the pair settle down on gravelly bottom side by side to rest. The female often lies on her side, and both fish breathe heavily as though exhausted. As soon as the splashing ceases, the water is seen to be slightly cloudy, probably due to the milt. The eggs can never be distinguished definitely, though occasionally a white speck can be seen as it floats downstream a short distance before lodging on some pebble. The spawning of the two fish is repeated again in about a minute, sometimes in the same place, often at some distance upstream or to one side.

The eggs seem to be scattered broadcast quite carelessly, and in no instance was any attempt observed to cover the eggs with pebbles after they had been deposited. Careful examination of the entire region of

the riffles failed to show any unusual mounds or depressions which might have been the work of the breeding dace. Nor was any dace ever observed to pick up and carry a pebble. A female pursued by several males will often spawn with one male at a considerable distance from the place in which she had spawned just previously. The choice of the spawning site does not seem to be important. The spawning behavior of the black-nosed dace seems to correspond in general with that of the red-bellied dace, as recorded by Smith, 1908, although the details of the process differ. While it seemed to be the usual procedure

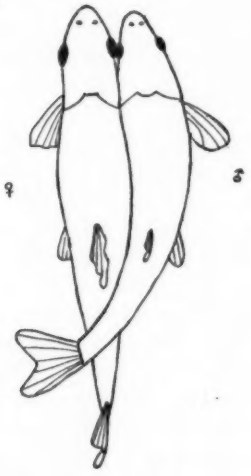

FIG. 1. POSITION OF SPAWNING DACE

for two males of the red-bellied dace to spawn at one time with one female, no such instance was observed with the black-nosed dace, although it sometimes happened that two males, one on each side of a female, would seem to contest as to which should spawn with her. First one and then the other would attempt to throw his tail over her body, the result usually being that the two took turns in spawning with her. The normal position for the male and female seems very much the same as that of an unusual case in the red-bellied dace, except that in the black-nosed dace the female apparently was not crowded up against a stone.

The males are very active at this time, and will often chase one another quite savagely. A male will sometimes take up a certain position, seemingly with no reference to its suitability as a spawning site, and maintain it for some time against all intruding males. On June 4th, a medium-sized male was seen to take up such a position in the current, just above a bed of small pebbles, head upstream, resting over the center of the depression. This depression was probably natural; at any rate, while under observation for three-quarters of an hour, he made no attempt to excavate it. Several times he chased off intruding males, and then, as if tired of waiting, set forth in quest of a female. Twice he went out unsuccessfully, each time returning to drive off other males. Suddenly a large female pursued by seven males of varying sizes came near, and he joined the chase. The group entered his guarded area, and one male succeeded in spawning with the female, after which all went upstream. The first male soon returned to defend his ground, only to be met by two invaders at once. A battle ensued, which lasted fully three minutes, the invaders being hard to vanquish. Before it was settled, a small female and two males entered the contested ground, at which the three stopped their dispute and gave chase, but none succeeded in mating with her near the depression. The fight was then resumed for a longer time, the three being about matched in size and the outcome doubtful. One was at length victorious, and took his stand over the depression. Later, two other males were observed guarding definite stretches of the riffles, but here there were no depressions. This instinctive guarding of a certain locality seems to have no reference to possible nest-building, but to be merely an outgrowth of the male's zeal for mating.

Strangely enough, the same instinct which causes one male to pursue other males and contest with them, seems likewise to cause two males, who for a time can find no females, to consort with one another in a peculiar fashion. Two were thus observed at close range. One, a large male, was swimming restlessly about, and the other, a smaller less bright-colored male, was resting near a tuft of grass, head upstream. Frequently the two approached each other, the smaller beneath the larger, his head pressing upward against the under side of the body of the larger in the region of the pectoral fins, the caudal fins of the two fishes approaching one another and moving with a peculiar fan-like vibration.

The spawning activities seem to decrease toward noon, so that after one o'clock the females were seldom seen, though the males still splashed

and leaped about in the shoals, two often consorting together as just described. Observations during the afternoon usually failed to yield any data on mating activities, the females being for the most part concealed under stones or the overhanging bank. The fish were seen spawning on June 4th, and a few on June 6th, but the main activity seemed to have passed. Gradually the larger dace returned to their usual habitat in the swifter and deeper waters of the main stream, leaving the shoals of the branch stream in the possession of smaller fish.

Some of the breeding fishes were distinctly smaller than others, these smaller ones falling into the group which seems to represent fishes of the second year. As still smaller ones were present in other parts of the stream but not on the shoals with the breeding fishes, and as none of these smallest fishes showed any color changes in the males, it seems probable that the majority of black-nosed dace do not breed until their second year. Nine female dace taken at random from the spawning grounds on May 29 and June 2, averaged 55.5 mm. in length, the smallest measuring 52, the largest 62 mm. The average weight of these females was 2.8 gm. The average length of 19 males taken at the same time and place was 54.8 mm. these ranging from 47 to 63 mm. These males had an average weight of 2.7 gm. Thus the average length and weight of the breeding females exceeded that of the breeding males by 0.7 mm. and 0.1 gm., respectively.

Eggs

Six large female dace were taken the last week of May for examination of the ovaries. In three of these, measuring respectively 55, 57 and 55 mm., the eggs were mainly large, while in the other three, measuring 62, 52, and 51 mm., the eggs were still small and greater in number. Four hundred and twenty-eight was the least number of eggs found in any of the six fishes, 1116 the highest, giving an average of 746 eggs per fish, which may be a low estimate. Eggs taken from these females were similar to those collected later from the riffles over which the spawning activities were observed.

Careful examination in various places where the dace had spawned failed to show the location of the eggs, but many of them were easily collected on a net by stirring about among the gravel and pebbles in the riffles, meantime holding the net a little way downstream so that the current flowed through it. More than 30 eggs were taken in this way on June 4, and 80 more on June 6, along with a number of fry which had

just hatched. These eggs measured 0.8 mm. in diameter, and were of a light amber tint, nearly transparent. When brought into the laboratory and placed in quiet water, they hatched in a few hours.

Fry

Some of the fry which had hatched on June 4 lived for four or five hours, but most of them died much sooner. One of the fry collected on June 6 was found to measure 5 + mm., immediately after hatching. Thirty-six of the eggs and fry collected on this date were placed in a trough of cold running water in the fish hatchery. Here many of the eggs hatched, and the fry were still alive and seemingly healthy on June 24, still retaining their yolk-sacs. A few days later they escaped into the main trough and were lost, so none were reared to fingerling size. The cold water probably retarded their development, as young dace taken from the stream on July 7 had no yolk sacs and had been feeding. These fingerlings were found mainly over the shoals near the banks of the stream, swimming in schools quite near the surface, and already showed the distinguishing black line around the body.

GROWTH AND AGE DETERMINATION

Growth

The record of the length and weight,—average, minimum and maximum,—of the young dace used in the study of food will be found in Table I. Recalling that the newly-hatched fry measured 5+ mm., the gain in length of a black-nosed dace month by month throughout the first year of its life is readily estimated, also its average monthly gain in weight after the first week in July. The average length of these fishes at the end of their first year does not exceed 36 mm., nor their weight 0.7 gm., though immature individuals may be taken measuring 41 mm. and having a weight of 1.0 gm. None of the black-nosed dace taken in Cascadilla Creek had attained a greater length than 63 mm. The smallest male dace taken, which showed the characteristic breeding colors, was caught on March 20, and measured 44 mm.

Age determination

Length-weight curves of three groups of dace taken on the same or approximating dates, at different seasons, are given in Figs. 2–4. The curve for the 38 fishes taken on Nov. 9 seems to show three age-groups;

the first, from 21–33 mm., and 0.15–0.5 gm.; the second, 37–44 mm., and 0.7–1.45 gm.; the third, 52–59 mm., and 2.4–3.5 gm. This is interpreted as a grouping of first and second year fishes, with a third group of older ones. The May 29–June 2 curve shows a clear division of the 51 fishes represented into two groups, the immature ones 29–41 mm. and 0.35–1.0 gm., the breeding fishes 47–63 mm. and 1.4–4.7 gm. No separation of the latter group is evident. The third curve, of 19 fishes taken Aug. 19, shows a definite first-year group, and an indefinite second

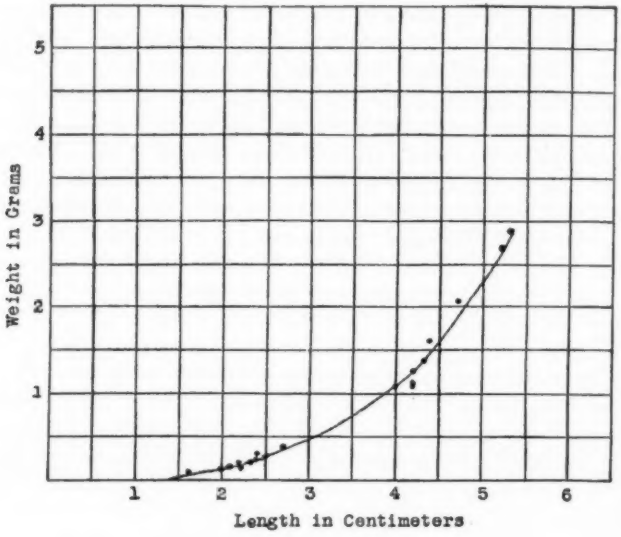

FIG. 2

group which might be interpreted as having two divisions: (a) second-year fish, 40–47 mm. and 1.1–1.6 gm., and (b) older fishes, 52–54 mm. 2.7–2.9 gm. Thus with the exception of the Nov. 9 curve, it is doubtful if any certain division can be made between second-year and older dace, and no age-group beyond the second year is even suggested.

The use of scales as an index of size and growth of these fishes has not proved satisfactory to date, as the methods employed have failed to show any approximation of the ridges which might indicate renewed growth after the winter period, nor have any definite annuli or winter

marks been discovered. It is possible, however, that more work in this field, employing the methods recommended by Creaser (1926) might be more fruitful. In the scales of *Rhinichthys*, radii are present in both the anterior and posterior fields.

Various bony structures of the dace have been examined for indications of growth and life history markings. The vertebrae, the otoliths, and a small flat bone nearly circular in outline, lying in front of the pectoral girdle, which is doubtless the supratemporal, have been used with but little success. In the case of the vertebrae and otoliths, as in the length-weight curves, it has been possible to determine with some accuracy the age of a dace up to the end of the second year, but no further. The supratemporal bone, however, shows broad light zones alternating with narrow slightly darker ones, though no ridges (concentric growth lines) were discerned. Such a bone from a 63 mm. dace seemed to show four broad and three narrow bands of this sort, which might be interpreted as indicating that the fish was in its fourth year. Much more work needs to be done on scales and perhaps the supratemporals, however, before any estimates can be made as to age-groups beyond the second year, and as to the age which these minnows may attain.

SUMMARY

1. Parasites, both internal and external, frequently infest the black-nosed dace. The internal parasites give no external evidence of their presence.

2. Young dace (in their first year) feed principally upon Chironomid larvae, with mayfly nymphs second in importance, the total insect material taken by this group amounting to 67%. Plant material forms 23% of their food, of which 18% is diatoms. Crustacea are taken sparingly during the first summer and autumn. The very young dace are seen to feed largely from the surface; somewhat older ones feed also from the middle and bottom zones.

3. Older dace are likewise insectivorous, taking Chironomid larvae and mayfly nymphs in almost equal proportions. However, insect material forms but 47% of the total food of this group. Plant material is now increased to 36%, of which 29% is diatoms. These larger dace feed mainly from the middle and bottom zones, though occasionally rising to the surface.

4. The fact that two young dace taken in January were empty, while two older ones taken at the same time had fed but sparingly, might indicate a lowered feeding activity during very cold weather.

5. Food of all dace during the colder months was mainly aquatic insect larvae, suggesting bottom feeding during this peroid.

6. It seems doubtful that the large amounts of plant material taken by the older dace are purely accidental, as suggested by Breder and Crawford.

7. Evidence seems to favor the view that these fishes, like many others, are selective in their feeding, preferring certain foods when these are obtainable.

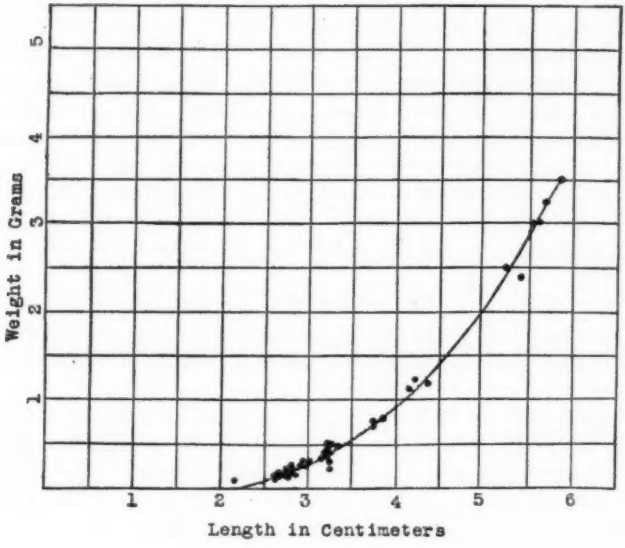

FIG. 3

8. Observations on the breeding habits of the black-nosed dace in Cascadilla Creek do not accord with the published accounts of Gregg, Holder and others. It seems probable that the minnow observed by the two former writers was not *Rhinichthys atronasus*. The breeding behavior and nest-building habits of the horned dace, *Semotilus atromaculatus*, as recorded by Reighard (1910) are sufficiently similar to the descriptions given by Gregg and Holder to suggest a confusion of these species by the two men. It is also possible that *Campostoma anomalum*

or *Hypopsis kentuckiensis* may have been the fish whose actions Gregg and Holder described.

9. The breeding dace leave their usual haunts in the deeper portions of the stream and make a short migration to the shallow waters of shoals and riffles to spawn. They vary in size, but no first-year fish have been seen among them. The breeding females slightly exceed the males in size.

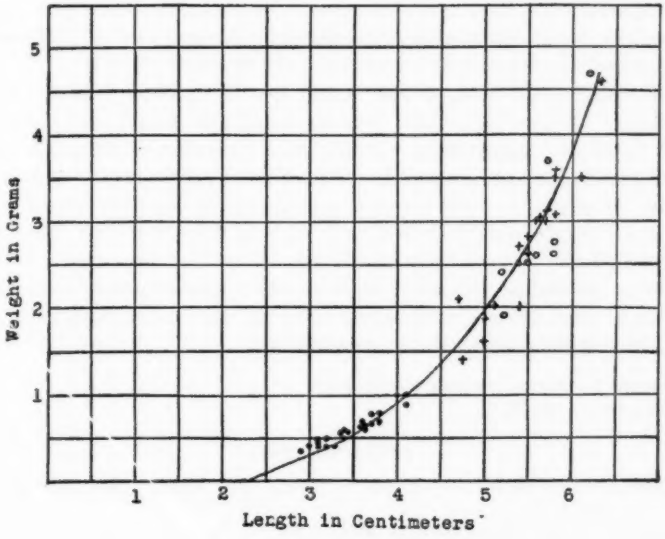

FIG. 4.

10. The males are very active at this time, splashing and leaping about, and seem to congregate in schools before the females appear. While they frequently fan or upturn the gravel, none has ever been seen to make any excavation or to pick up or carry a pebble.

11. Spawning activities of the dace are at their height in Cascadilla Creek during the first week of June, the hours between 11 a.m. and 1 p.m. seeming to be the most favorable. It is only during this period of the day that the females leave their hiding places and join the males on the shoals.

12. Spawning occurs at random over any portion of the shoals.

Many males pursue one female, each striving to spawn with her. The female is passive during the act of spawning, the male pressing against her and setting his body into rapid vibration, meantime throwing his tail over hers and splashing in the water on the opposite side. The eggs float downstream a short distance before lodging among the gravel.

13. Two males often chase one another, but occasionally two which can find no female seem to consort together in a peculiar fashion.

14. The eggs of the black-nosed dace are 0.8 mm. in diameter, nearly transparent, and light amber in color. Newly-hatched fry were taken from the shoals along with the eggs, but attempts to rear them were unsuccessful. When just hatched, the fry measured 5 mm.

15. Fingerlings taken on July 7 had lost the yolk-sac and had been feeding. On this date, their average length and weight was 17.5 mm. and 0.089 gm. respectively. Young dace by spring of their first year had attained an average length of 36 mm. and weight of 0.71 gm.

16. Attempts to determine the age-groups of the dace studied, by means of length-weight curves, were successful for first-year fishes and partially so for those in their second year but not for older ones. Examinations of scales, vertebrae, otoliths and supratemporal bones have failed to yield definite information as to the age and life-history of the fish from which these structures were taken.

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THE RELATIONSHIP OF MICROSTROMA JUGLANDIS (BERENG.) SACC.

By Frederick A. Wolf

Plate 6

The attention of mycologists has been directed, in two recent papers (7, 11), to the morphology and taxonomic position of the genus *Microstroma*. The former concludes that *Microstroma* must be placed among the Basidiomycetes near *Exobasidium* and the latter regards it as one of the Fungi Imperfecti among the Melanconiales. Further consideration has therefore been given this interesting fungus, in part, because of this lack of agreement between the observations and interpretations recorded in these two papers and, in part, because each of these divergent views on the systematic position of *Microstroma* has been supported by various other investigations.

Both Miss Pires' studies (7) and those of the present writer (11) have been concerned primarily with *M. juglandis*, the type species which is of common occurrence on hickory throughout the United States and with a variety, *robustum*, which occurs on pecan catkins. This variety was first described from Georgia by Higgins (3). The present report is based upon a re-examination of the prepared slides used in my previous study, supplemented by collections, made during 1928, of the fungus on hickory. Bouin's killing fluid was used with these later collections and the sections were stained with Haidenhain's iron alum haematoxylin.

An examination of previous investigations of *Microstroma juglandis* shows that Berenger (1) who first described it in 1847, as *Fusidium juglandis*, regarded it as one of the Moniliales. Niessl (10) in 1861 based the genus *Microstroma* upon this fungus as the type species and designated it therefore *M. juglandis*. He, too, regarded it as one of the Moniliales of the group Mucedinaceae-Micronemeae. Niessl's classification was accepted by Lindau (4) and by Saccardo (8) in their classical compendia. More recently Maire (5) published an account of his studies and concluded, from histological and cytological evidence, that the correct position of this fungus is among the Melanconiales near

Colletotrichum and *Cylindrosporium*. That *M. juglandis* is not a Basidiomycete is concluded from my previous studies (11) which confirm those of Maire (5), for the following reasons: (1) the conidiophores are polynuclear, which is not characteristic of Basidiomycetes. (2) the conidia are not inequilateral but symmetrically oblong-elliptical and have a central basal hilum whereas basidiospores are extrorsely attached; and (3) the fungus lacks conjugate nuclei which occur in many Basidiomycetes.

Schröeter (9), who appears to be the first to regard *Microstroma* as a Basidiomycete, made a careful study of its morphology. He classified it among the Exobasidiales because of the similarity of its conidiophores and of the basidia of *Exobasidium*. Hennings (2) adopted Schröeter's classification as has been done subsequently by a number of other systematists. Moreover, Patouillard's (6) interpretation of the fruiting structures of *Microstroma* accord with Schröeter's (9) and he chose to place it as a subgenus of *Exobasidium*.

The possession by this fungus of three basidiomycetous characteristics, namely; (1) clavate basidia, bearing sterigmata, constant in number, on which spores are produced singly, (2) clamp connections between mycelial cells, and (3) binucleate mycelial cells, lead Pires (7) to conclude that it must be placed among the Basidiomycetes.

All who have examined the fructifications of *Microstroma* appear to be in accord, when judged by their published descriptions and illustrations, as to its gross structure. Each pustular fructification is seated within the tissues of the suscept and extends to the surface through a stoma. Each pustule, moreover, consists of a dense, fascicular aggregate of hyphae which do not form a pseudoparenchyma tissue.

The hyphae remain more or less parallel and are loosely interwoven throughout except as they converge at the stomatal orifice where they are somewhat compacted. In consequence of this convergence the form of an entire pustule simulates that of a sheaf of grain.

An aggregation of clavate cells each of which terminates a hypha makes up the aerial portion of the pustules. Each clavate cell bears a crown of papillae or sterigmata on which are formed the compliment of 2 to 6 spores. As is apparent, these structural features, except for the aggregation of fertile hyphae into fascicles, agrees well with those possessed by the genus *Exobasidium*. It should be borne in mind, however, that the conidiophores of certain imperfect fungi are dilated apically and bear their conidia on papillate stalks resembling sterigmata. For this reason, the gross structure of *Microstroma juglandis* might

lead to a misinterpretation of its systematic position. Undoubtedly, in the present case, less significance should be attached to the structure of the pustules than to the cytological characters as a taxonomic criterion. The small diameter of the hyphae and of the nuclei of *Microstroma* as indicated by Maire (5) and Pires (7) render a cytological study rather difficult.

In Basidiomycetes, at time of spore formation, the nuclei which have been formed free within the basidium migrate simultaneously through the sterigmata into the developing spores, thus leaving the basidia destitute of nuclei. Pires' figure 7 shows that the basidia of *Microstroma*, bearing spores, lack nuclei. This is not in accord with figure 5 of my previous account (11) nor with my present observations, figs. 1 and 9.

During the past summer the removal of the film of spores from a young leaf-lesion was followed by the production of another powdery, white layer. The most reasonable explanation of the source of this new layer of spores lies in the fact, as may be seen in serial sections of any lesion, that not all fructifications are in the same state of maturity at the same time and therefore all may not bear spores at the same time. That this is a partial explanation only rests upon two additional observations. The first of these is that there remain within basidia which bear mature spores structures which, because of their staining reaction with iron alum haematoxylin, are interpreted to be nuclei. These are shown in figs. 1 and 9 accompanying this paper and fig. 5 of the previous account. These nuclei could be expected to take part in the formation of spores to replace those which had been removed, but it has not been possible to prove that they do function in this manner. The second of these observations appears not to have been made previously and is represented in fig. 9. This shows within the same pustule stages in development varying from young fertile hyphae to mature sporiferous cells. The young fertile hyphae extend upward from the base of the pustule. They contain, as shown by figs. 1 and 9 and also by Pires' fig. 6, numerous nuclei and a deeply stained protoplast. As they approximate the stomatal orifice they become clavate and after coming to the surface of the leaf a septum is laid down which delimits the fertile cell. Prior to the formation of this septum, however, the protoplasm and nuclei have largely passed into the apical sporiferous cell. Those hyphae whose development is delayed may extend to the surface to replace those which have shed their spores and thereby prolong the period of spore formation from any particular pustule.

This interpretation of the course of development is made because the apices of young fertile hyphae are not truncate but rounded. Moreover, when they are viewed under oil immersion with a binocular they appear to lie in a different plane from those which bear a crown of spores and to be not continuous with them. The hyphae which have cut off the terminal fertile cell are almost destitute of stainable material and can be traced downward into the pustule considerably beyond the tips of the young hyphae. Further evidence that not all conidiophores mature at one time comes from the fact that the number of hyphae comprising the portion of the fascicle within the leaf always exceeds the number of clavate cells at the surface.

The intercellular hyphae, distant from the fructifications, provide the most suitable material for a study of whether or not the cells are uninucleate or binucleate. Maire (5) summarized his observations on this point by stating that the cells of the mycelium "are almost always uninucleate." My own observations accord entirely with those of Maire. Occasional cells have been observed to be binucleate. When the nuclei occur in pairs in the cells of the vegetative mycelium they appear to have resulted from the division of a nucleus and can most often be found in cells from which branches are arising, fig. 6, or in cells in which presumably a septum is to be formed. Figure 4 by Pires (7) does not show binucleate cells but four and five pairs of nuclei in the portion of the cell represented. She furthermore states that she is doubtful whether the structures in fig. 3 are really nuclei. At any rate there appears to be no evidence that conjugate division of pairs of nuclei occurs within the mycelium of *Microstroma*, a phenomenon known to occur among certain Basidiomycetes.

Considerable interest has centered, as recorded in several recent studies which are briefly reviewed by Pires (7), in the significance of clamp connections in Basidiomycetes. Pires' figure 6 is interpreted to be typical of the clamp connections in *Microstroma* and fig. 8 to be elongated structures resembling clamp connections. The fact that "they are cut off from two cells" is the basis for concluding that they are not ordinary branches. My own observations on these structures show that these peculiar branches are of common occurrence on the intercellular mycelium. Hyphae may show short side branches which merely protrude from the parent cell as shown in fig. 2. These branches may be separated from the parent hypha by a septum at the juncture with the parent hypha, fig. 2. Such cases which are of common occurrence lead one to conclude that the relationship of cells shown in figs.

3, 4, 5, 6 arise by the formation of the basal septum of the branch first and then of a septum at right angles to the basal septum. The branch thus appears to arise from two cells. At any rate when one finds that these apparent clamps are segmented and that these clamps themselves give rise to other clamps, figs. 3 and 6, one is forced to conclude that this condition merely represents a peculiar method of branching. This conclusion is furthermore supported by the fact that the branch cells contain single nuclei just as do the parent cells.

Manifestly the most convincing proof that *Microstroma juglandis* is an imperfect fungus depends upon connecting it with some perfect stage. The discovery of such a stage would, of course, put to rest any need for morphological and cytological evidence to determine its taxonomic position. The cytological study of an organism as minute as this one can be expected to lead to possible errors in observation and interpretation, and in consequence mycologists will not be in accord.

It may be recapitulated, in summary, that the distinguishing characteristic which strongly indicates that *Microstroma juglandis* is a Basidiomycete is the possession of clavate basidia, bearing sterigmata, on each of which are produced single, non-catenulate spores. That it is an imperfect fungus, as the present writer is inclined to regard it, is indicated by (1) the polynuclear condition of the conidiophores, (2) the presence of nuclei in cells bearing a crown of mature spores, (3) the presence of the same pustule of both very young, intermediate, and mature conidiophores, (4) the attachment of symmetrical spores with a central basal hilum, (5) the absence of clamp connections, (6) the occurrence of uninucleate cells in the vegetative mycelium, and (7) the absence of conjugate nuclei.

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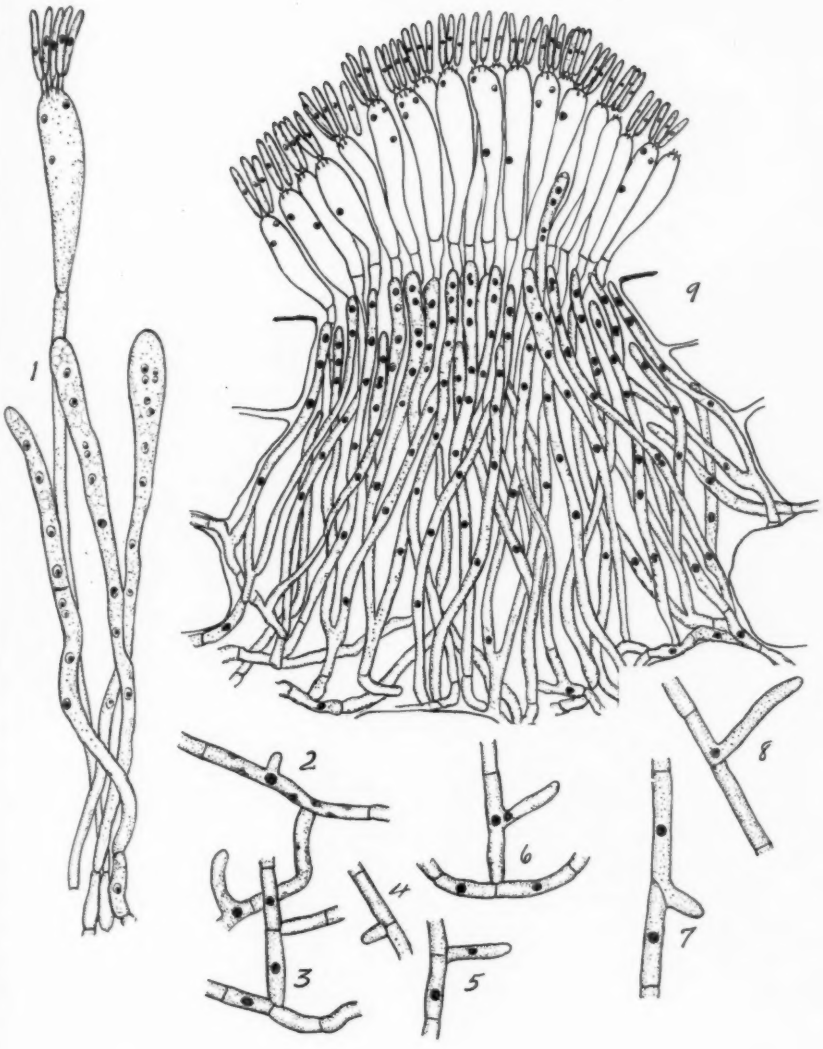
EXPLANATION OF PLATE 6

All figures are semidiagrammatic but are drawn with a camera lucida. Figs. 1–8 are drawn to the same scale

1. Portion of a pustule of *Microstroma juglandis* var. *robustum* showing three polynuclear fertile hyphae in different stages of development and one mature conidiophore with an empty basal cell, a clavate terminal cell with a crown of uninucleate spores 15μ in length and three nuclei left within the terminal cell.
2. Intercellular mycelium of *M. juglandis* with two protruding branches, one of which has a basal septum and is itself branched.
3. A mycelial branch borne by two basal cells which is in turn branched. This secondary branch arises from two uninucleate cells.
4. Short branch, of common occurrence showing the peculiar method of branching of this fungus.
5. An elongated branch with a single nucleus, borne on two cells.
6. An elongated branch, which is septate and whose branching cell is binucleate.
7. An oblique septum.
8. A septum in the main hyphae with none at the base of the branch.
9. Vertical section of pustule of *M. juglandis* var. *robustum* showing form of pustule, position within the stoma, interwoven multinucleate fertile hyphae, in various stages of maturity, and mature hyphae with apical clavate cells bearing spores.

PLATE 6



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SWEET POTATOES INFECTED BY SCHIZOPHYLLUM COMMUNE[1]

By R. F. Poole

Plates 7–9

Schizophyllum commune Fries is widely distributed in nature, and is chiefly known for its xeric habits and ability to destroy wood. In recent years, Essig,[2] Putterill[3] and others have found that *Schizophyllum commune* attacks live tissues. Investigations conducted by these workers and others whom they cite, have shown that this fungus attacks and causes diseases of sugar cane, shade, nut and fruit trees. Putterill found that the mycelium and accompanying wood discoloration required eighteen to twenty-four months to reach a diameter of one-half to an inch away from inoculation centers in apricot wood. He also maintained that infected wood is not delignified as is usually the case with wood destroying fungi, but that the cellulose is made use of in the activities of the fungus. In pure cultures it was found to produce cytase, diastase, emulsin, invertase, maltase, and lipase, which accounts for its wood destroying powers. The morphogenesis and economic importance of the fungus and its effect on woody plants are now fairly well known.

The physiological diseases of fruit and other trees in this state are common and they prepare an ideal entrance for *Schizophyllum commune*. Winter injury, frost injury, sunscald, fire and mechanical injuries of various sorts have made it possible for this fungus to enter tissues, which otherwise would not have become infected. A very common source of entrance is through large scars after pruning. Throughout the sand hills, the fungus is very prominent on peach trees, killed and partly

[1] Published with the approval of the Director of Research as paper number 32 of the Journal Series.

[2] Essig, F. M. The morphology, development and economic aspects of *Schizophyllum commune* Fries. Univ. Cal. Publ. Bot. **7**: 447–498. 1922.

[3] Putterill, V. H. Biology of *Schizophyllum commune* Fries with special reference to its Parasitism. S. Africa Ag. Dept. Sci. B. **25**: 1–35. 1922. (3d.)

killed by winter injury (pl. 7). Sporophores, which increase in number each season, live for more than three years on the dead wood (pl. 7). During the past three years the death of several apple trees on the North Carolina State College Farm was partly due to this fungus. Infection had occurred in pruning scars and fire blight cankers. Sporophores on parts injured by sunscald and low temperatures are most conspicuous on the tissues nearest to the live wood, where water is probably the controlling factor (pl. 8). They are not as prevalent but are frequently found on live tissue (pl. 8). Other trees attacked by this fungus are pine (*Pinus echinata*) and mulberry (*Morus alba*), and still others may be attacked. Although these observations were made quite extensively during the past three years this report on hosts must not be considered complete. The fungous sporophores were found on stumps of the pine and on injured areas of the mulberry.[4] The parasitic activity of the fungus in this state is of some, but not of serious economic importance. The infection of the cherry and apple is of sufficient importance to warrant a study of disinfectants as a measure of protection for all injured tissues.

A large number of investigators have associated *Schizophyllum commune* Fries with the destruction of woody plants. In the literature published concerning this fungus, there seems to be no report of it attacking tubers or any fleshy rooted plant. During April 1927 it was found in Currituck County on the Big Stem Jersey variety of sweet potato (*Ipomoea batatas*). Infected potatoes contained few to 67 sporophores which ranged in sizes from one to 30 millimeters in diameter (pl. 9). Infected potatoes were found in several fields, but in no case restricted to any specific area such as well or poorly drained soils. There was no evidence found to indicate that the fungus was parasitic, because the infected potatoes had remained on the land since August 1926, when the crop was harvested. Furthermore, plants and potatoes in the plant beds in this same area showed no infection when examined at the same time the specimens were obtained. The exact time infection took place was not ascertained, but the mummified condition of the potato and the mature sporophores indicated that both had taken place sometime between August and December. Some, but not all, of the potatoes attacked by *S. commune* were infected with *Sclerotium bataticola* and *Rhizopus nigricans*. However, all of these fungi were apparently prevalent on the sweet potato, without there being any direct relation.

[4] We have found *S. commune* also on English walnut, apple, peach, *Rhus*, mimosa and *Gordonia* (W. C. Coker).

PLATE 7

[Above] Elberta peach tree partly killed by winter injury, attacked by *S. commune*. Sporophores are abundant on the dead parts and up to the margin of live tissue

[Below] Peach twigs with many sporophores, xeric and increasing each season

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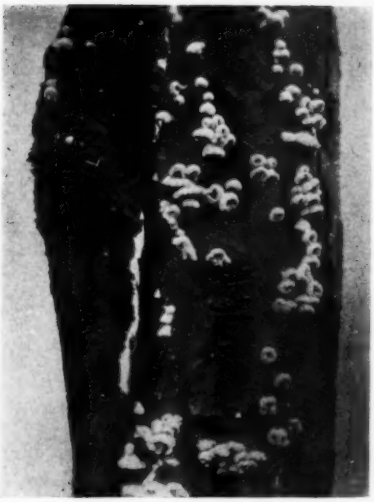
PLATE 8



[Above] Sporophores on live apple wood

[Below] Stayman winesap apple tree injured by sunscald or low temperatures, attacked by *S. commune*. Photograph by M. E. Gardner

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PLATE 9

[Above] Sweet potatoes showing ventral surface of sporophores of *S. commune*
[Below] Sporophores of various sizes on dorsal side

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The fungus was isolated by the ordinary procedure and cultured on a prune medium. It has since been successfully grown and maintained on a large number of plant decoctions and synthetic media. On all media used the mycelium is white and develops in abundance. There is no color pigment or clouding of the medium. When grown on a sweet potato medium and placed in light at an ordinary room temperature, sporophores were developed in 30 days.

Potatoes were cut into halves and quarters, heavily inoculated with mycelium, and placed in large test tubes, and just beneath sand in pots. These were kept moist and at 25°C. Infection took place in both tests. The fungus penetrated the tissues slowly and a typical "dry rot" was produced. Other than a slight browning, there was no discoloration of the tissues. After the cells collapsed much of the carbohydrates remained in mass in the shrunken potato. Sporophores were produced after two months.

This finding of *S. commune* Fries on the sweet potato and positive results with pure culture inoculations will be of some interest, but is not at this time of any economic importance. The fungus is added to the already long list of fungi that attack the sweet potato during the period of dormancy. In this respect the disease is not unlike others that occur in storage.

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AEOLIAN SAND AND OIL-BEARING STRATA IN SAKHALIN

By Collier Cobb

As petroleum geologists all know, *aeolian* is a name given to a kind of wind-blown sand found in oil-bearing strata. The coarsest aeolian sands are the largest oil-yielders, and from deposits of this kind practically all of the big Baku spouters have been obtained. The oil does not originate in the wind-blown sands. It is only stored there, being driven upward into such sands by the metamorphism of underlying organic deposits. Sometimes these may be animal forms, as fish remains in the petroliferous calcareous shales of the Green River district of Wyoming, in which the fossil fishes show every bone of the skeleton preserved. Again the oil may be derived from plant forms, as seen in peat deposits in marshes where partial decomposition of plants has taken place amidst much moisture, and this may account for the presence of ozokerite in some of the peat mosses of Russia. But attempts to obtain inflammable oils, burning gas, tar, etc., from the destrictive distillation of peat have never been successful in a practical way. The fields of Karafuto indicate that Nature's processes are more successful than anything that man has been able to do in his laboratories.

But most geologists are firmly of the opinion that all rock oils are of organic origin; and Credner was strongly inclined to classify petroleums with guanos on account of a similar organic origin. Antoine LeBel acknowledged the organic origin of all rock-oils; but was satisfied that the forces producing them could not come into play except under the influence of a reaction originating in other strata than those bearing the petroleum.

All of this is well illustrated in the strata under consideration. Karafuto, or more properly Sakhalin, is a long and somewhat narrow island running north and south lying close to the east coast of Siberia. Its area is 30,000 square miles, one half belonging to Japan, and half to Russia.

The island has its mountains, hills, and valleys, with intervening plateaus and flat plains. It is largely covered with fertile soils and forest lands; but it also has extensive peat bogs and vast swamps. Large

areas of these swamps are impregnated with oil. This is not a local deposit, but extends along the eastern coast, particularly along that of Russian Sakhalin. The chief oil-bearing deposits of this region are in the Nuroto and Botesa fields. The inland movement of the dunes over the peat beds has compressed the land on the shore line and caused the strata to buckle up before the advancing sand-wave, as observed in the Ichigo Oil Field at Niigata, Japan, and already reported to this Academy.

The same action of the sand-wave in causing the upbuckling of the strata was noticed by Berendt on the Baltic Sea and is recorded in his "Geologie des Kurischen Haffis," Königsberg, 1869, pp. 18–20, in which he remarks that he has 'observed on the Kurische Nehrung the disturbing influence of a steep dune by unilateral pressure upon underlying marl deposits.' In this case, he refers to the "Mergelboden" of the Haff, which 'has been pressed upward at the foot of the steep dune to a height of five m.'

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THE DISTRIBUTION OF SUGAR IN THE BLOOD OF FISHES[1]

By I. E. Gray and F. G. Hall[2]

Few observations have been recorded of the distribution of sugar in the blood of the poikilothermal animals. Among the mammals this subject has been studied by a number of workers. Of the numerous accounts of the distribution of sugar in humans perhaps that of Wu (1922), is as representative as any. Wu found the average sugar of twenty humans to be 99.9 mg. (per 100 cc.) in the corpuscles and 103.2 mg. in the plasma, showing that distribution is nearly even. The discrepancy is in favor of the plasma. Seldom is there more sugar in the corpuscles. This appears to be true under various conditions, such as diabetes or following insulin administration. Wishart (1920) and Shope (1928) have studied the sugar distribution in other mammals. The latter writer has noted a marked species variation and gives the percentage of total sugar in the corpuscles of the various species as follows: swine, 24%; guinea pig, 48%; cattle, 30%; rabbits, 20%; and human, 49%. He has also calculated from Wishart's data the percent of total sugar in the corpuscles: dog, 20.2%; pony, 74.5%; goat, 12.3%; and sheep, 47.7%. These figures may be of interest for comparison with the following data.

Methods. Analyses showing the distribution of sugar in the blood of fishes were obtained from the following species: the freshwater pickerel, *Esox lucius* (Linnaeus), the menhaden, *Brevoortia tyrannus* (Latrobe), scup, *Stenotomus chrysops* (Linnaeus), shad, *Alosa spaidissima* (Wilson), silver hake, *Merluccius bilinearis* (Mitchill), and the dogfish, *Mustelus canis* (Mitchill).

The investigation was carried on at the United States Fisheries Laboratory at Woods Hole, Mass. The fishes were caught in fish traps and were kept in large floating "live cages" for one or two days before use. The analyses of the pickerel blood were made at the

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] From the Zoological Laboratory of Tulane University, and the Zoological Laboratory of Duke University.

University of Wisconsin. The pickerel marked "normal" in table II were kept in large concrete tanks with running lake water for several days. Four pickerel were bled within a few hours after being brought to the laboratory and were not given sufficient time to recover from asphyxiation incurred incidental to capture in gill nets. These are indicated as "partially asphyxiated."

Blood was obtained by severing the tail and collecting in small Erlenmeyer flasks containing enough lithium oxalate to prevent clotting. The Folin-Wu method was used in determining the sugar of the whole blood and of the plasma of the pickerel. Folin's modification of the Folin-Wu method (Folin, 1926; Folin and Svedberg, 1926), which gives about ten per cent lower results, was used for the determination of the whole blood sugar and plasma sugar of the marine fishes. Corpuscle sugar was obtained by the indirect method. After removing sufficient blood for the estimation of the whole blood sugar, the remainder was centrifuged at high speed for ten minutes in order to obtain the corpuscle volume as well as plasma for the determination of plasma sugar. Knowing the whole blood sugar, plasma sugar, and the corpuscle volume, the corpuscle sugar could be easily calculated from the following formula:

$$\frac{\text{WBS} - (\text{per cent plasma} \times \text{PBS})}{\text{per cent corpuscles}} = \text{CBS}$$

WBS, PBS, and CBS refer to the sugar in mg. per 100 cc. in whole blood, plasma, and corpuscles, respectively, while percentage plasma and percentage corpuscles represent the percentages of plasma and corpuscles in whole blood determined by centrifuging.

Results and Discussion. Tables I and II give the distribution between corpuscles and plasma in 13 menhaden and 8 pickerel. In table III is recorded a few isolated observations of blood sugar distribution in several marine fishes.

With the exception of one dogfish, it will be noted that the plasma sugar is greater than the corpuscle sugar, per unit of volume. This is true in mammals and is perhaps to be expected in fishes. Shope (1928) noted a species variation in sugar distribution in mammals that was not dependent on corpuscle volume. Although the data is limited in number of individuals of different species, the indications are that there is also a species variation in the distribution of sugar in fishes. This may be readily noted by comparing the plasma sugar—corpuscle sugar ratios of different species. Sugar was found to be about evenly distributed

between corpuscles and plasma in the two dogfish studied, while in the hake and shad it was about three and one half times greater in the plasma than in the corpuscles. The relative distribution in the other fishes ranged between these extremes.

It is essential in a comparative study of sugar distribution in fishes to use the plasma sugar—corpuscle sugar ratios and not the percentages of corpuscle sugar in the total sugar. Shope (1928), as a basis of comparison of the sugar distribution in mammals used the

TABLE I

DISTRIBUTION OF SUGAR IN THE BLOOD OF MENHADEN

NUMBER	CORPUSCLE VOLUME	SUGAR PER 100 CC.			PLASMA SUGAR / CORPUSCLE SUGAR	CORPUSCLE SUGAR IN TOTAL SUGAR
		Whole Blood	Plasma	Corpuscle		
	per cent	*mg.*	*mg.*	*mg.*		*per cent*
1	41.8	151.5	181.8	109.3	1.66	30.1
2	40.8	84.0	107.5	49.9	2.15	24.2
3	38.3	81.3	99.0	52.8	1.87	24.9
4	53.2	77.2	120.5	39.1	3.08	27.0
5	36.5	97.5	108.6	78.2	1.39	29.3
6	51.6	61.0	96.1	28.1	3.41	23.8
7	40.2	68.9	91.3	35.6	2.56	20.7
8	55.6	62.3	88.5	41.4	2.14	36.9
9	45.7	73.9	100.0	42.9	2.33	26.5
10	29.0	64.5	75.4	37.8	2.00	17.0
11	40.6	66.4	80.0	46.5	1.72	28.4
12	40.3	70.7	83.3	52.0	1.61	29.6
13	34.7	68.2	79.0	47.8	1.65	24.3
Average	42.2	79.0	100.8	50.9	2.12	26.4

percentages of corpuscle sugar satisfactorily, since in the various animals he studied, the corpuscle volume was about the same. In fishes, however, the corpuscle volume varies considerably among the different species and to judge the variations in distribution on percentage of corpuscle sugar in the total sugar would be misleading. A brief study of the tables will make this clear. Scup and shad have very similar corpuscle volumes, but differ widely in percentage of corpuscle sugar. Menhaden and pickerel, on the other hand, have similar percentages of corpuscle sugar, but vary in the corpuscle volume. Again, the distri-

TABLE II

DISTRIBUTION OF SUGAR IN THE BLOOD OF PICKEREL

NUMBER	CORPUSCLE VOLUME	SUGAR PER 100 CC.			PLASMA SUGAR / CORPUSCLE SUGAR	CORPUSCLE SUGAR IN TOTAL SUGAR
		Whole Blood	Plasma	Corpuscle		
Normal						
	per cent	*mg.*	*mg.*	*mg.*		*per cent*
1	31.7	80.0	85.1	69.0	1.23	27.3
2	34.8	83.3	97.5	56.7	1.72	23.7
3	30.4	53.3	64.5	27.6	2.33	15.8
4	37.5	83.3	99.0	57.1	1.73	25.7
Average	33.6	75.0	86.5	52.6	1.75	23.1
Partially Asphyxiated						
5	30.2	184.2	200.0	147.7	1.35	24.2
6	35.3	197.0	218.4	157.8	1.38	27.7
7	40.1	410.8	428.4	384.5	1.11	37.5
8	38.3	419.6	441.2	384.8	1.14	35.1
Average	36.0	302.9	322.0	268.7	1.25	31.1

TABLE III

DISTRIBUTION OF SUGAR IN SCUP, HAKE, SHAD, AND DOGFISH

NUMBER	SPECIES	CORPUSCLE VOLUME	SUGAR PER 100 CC.			PLASMA SUGAR / CORPUSCLE SUGAR	CORPUSCLE SUGAR IN TOTAL SUGAR
			Whole Blood	Plasma	Corpuscle		
		per cent	*mg.*	*mg.*	*mg.*		*per cent*
1	Scup	51.5	46.3	55.5	37.6	1.47	41.9
2	Silver hake	20.8	85.4	101.0	26.0	3.88	6.3
3	Silver hake	17.9	50.3	57.5	17.3	3.32	6.1
4	Shad	52.6	86.2	140.8	37.0	3.80	22.5
5	Dogfish	29.0	65.3	64.9	66.2	0.98	29.4
6	Dogfish	25.0	85.5	87.0	81.0	1.07	23.7

bution of sugar in hake and shad is approximately the same, while the percentage of corpuscle sugar of the shad is over three times that of the hake.

The dogfish, like all elasmobranchs, differs widely in most respects from teleosts. A study of the distribution of blood sugar gives indication of another difference between these two groups of fishes. The sugar was about evenly distributed between corpuscles and plasma in the two dogfish while in the teleosts studied there was in every case decidedly more sugar in the plasma. It will be interesting in future work to see if the plasma sugar—corpuscle sugar ratios as found here will hold when more individuals are used, and also if the distribution in other elasmobranchs will be similar.

It is well known that asphyxiation tends to produce an increase in the amount of sugar in the blood of fishes. This accounts for the high sugars of the "partially asphyxiated" pickerel in table II. The average plasma sugar—corpuscle sugar ratio of the four asphyxiated pickerel was 1.25, while the normal fishes averaged 1.75, which gives a slight indication that an increase of sugar due to asphyxiation produces a change in the distribution. The degree of asphyxiation was not controlled, but pickerel numbers seven and eight suffered more than the other two, due to being tangled in the gill net. They were very weak when bled. These two fishes with the highest sugar had the lowest plasma-corpuscle ratios. Whether any significant can be attached to this cannot be decided until analyses of more fishes have been made under better controlled conditions.

Summary. Plasma sugar—corpuscle sugar rations of several species of fish are given. The distribution of sugar in the blood of fishes is similar to the distribution in mammals in that plasma sugar is greater than the corpuscle sugar. There is also an indication that the distribution of sugar in the blood of fishes, varies with the species.

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DISTILLATION PRODUCTS OF CELLULOSE

By H. B. Arbuckle and H. S. Davidson

In 1890, Dr. H. B. Arbuckle prepared a brown oil from paper which had remarkable curative properties for certain skin diseases, such as tetter, ringworm, and impetigo sores. He gave the name pyrolene to this substance. Several physicians have used it in skin treatments. Dr. Elliot, of Charlotte, N. C., in a paper before the North Carolina Medical Association in 1926 gave a very favorable report on its curative value. Cotton and high grade filter paper were used to prepare the pyrolene.

In 1924, Mr. F. C. Thames, in the course of an investigation of the preparation and composition of this product in the Chemical Laboratory of Davidson College developed, with the aid of Prof. O. J. Thies, Jr., a convenient method for the making of this material by the distillation of cellulose, in the form of paper, in a vacuum, and had identified several compounds when the work was interrupted.

The purpose of this study by the authors was to confirm the findings of Mr. Thames and to advance the study of the composition of this product of cellulose distillation. The separation of the various constituents was attempted by fractional distillation. The smallness of certain fractions and the minute amounts of distillates obtained in the purification processes were a great hindrance all through the work. Due to the many eutectic mixtures present in the pyrolene, it was impossible to effect a clean separation by this means. A third difficulty lay in the fact that there was a constant change in the composition of the original substance—a decomposition, molecular rearrangement or polymerization.

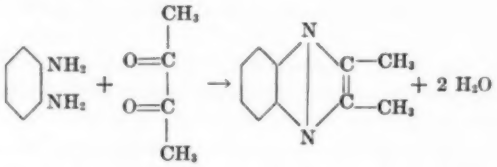
By the use of a twenty plate fractionating column, a separation was made up to 100.2°. When this temperature was reached, the distillation was continued in copper retorts. The following fractions were obtained:

Fraction Number		
One	Aldehyde-Ketone fraction boiling from	40–95°
Two	Formic Acid fraction boiling from	95–100.2
Three	Unnamed fraction boiling from	100.2–115
Four	Acetic Acid fraction boiling from	115–120
Five	Unnamed fraction boiling from	120–150
Six	Phenol fraction boiling from	120–280

The milk-ferric chloride test for formaldehyde was applied to fraction one. Formaldehyde was found to be present. When the redistilled fraction was treated with bromine solution, a compound of great lachrymatory properties was formed. This decomposed to such an extent on slight standing that no attempt was made to analyze it. From the redistilled fraction, iodoform and dibenzal acetone were prepared. This latter compound was found to melt at 112°.

$$2\ C_6H_5CHO + CH_3{\cdot}CO{\cdot}CH_3 = 2H_2O + C_6H_5CH{:}CH{\cdot}CO{\cdot}CH{:}CHC_6H_5$$

A portion of the fraction was then treated with orthophenylene diamine. Dimethylquinoxaline was obtained.



The nickelous salt of this was prepared and analyzed with the following results:

WEIGHT OF SAMPLE	WEIGHT NiO OBTAINED	THEORETICAL WEIGHT
0.1320 g.	0.0340 g.	0.0341 g.
0.1561 g.	0.0402 g.	0.0403 g.

In the redistillation of fraction one, the greenish-yellow vapors were much suggestive of diacetyl. Accordingly a portion of the first fraction was added to hydroxylamine and dimethylglyoxime obtained.

$$CH_3CO{\cdot}OC{\cdot}CH_3 + 2\ NH_2OH = CH_3{\cdot}C{:}NOH{\cdot}C{:}NOH{\cdot}CH_3 + 2H_2O$$

This was taken up in benzol and the bromine addition product, melting at 185°, was made and analyzed.

WEIGHT OF SAMPLE	WEIGHT AgBr OBTAINED	WEIGHT AgBr CALCULATED FROM $C_{16}H_{10}N_2Br_4$
0.0194 g.	0.0305 g.	0.0305 g.
0.0241 g.	0.0378 g.	0.0379 g.

Diacetyl was certainly present in this fraction. The presence of this interesting diketone in the decomposition products of cellulose offers

opportunity for making dimethylglyoxime and also the simplest types of azine dyes from this substance.

In fraction two, formic acid was found to be present to the extent of 2.08%. This is unusual, as in most papers on the subject, only traces of formic acid have been found. In fraction three, no substance was identified. The acetic acid in fraction four was determined and found to be 1.05%. This too is unusual, as the acetic acid is usually reported as being present in larger quantities. Fraction five was very small, and no compound was identified in it. The phenols were obtained from fraction six by means of extraction with 50% sodium hydroxide solution, separation of the two liqu d layers and precipitation of the phenols by means of carbon dioxide. In all the fractions one through five, there was an oil which could not be purified. When an attempt at distillation was made, the oil decomposed before beginning to distil.

Summary. 1. The method of vacuum distillation of cellulose under proper control gives good results. 2. Fractional distillation of the product in an effort at separation of the constituents is unsatisfactory, particularly at the lower temperatures, due to eutectic mixtures present 3. The following compounds have been positively identified: formaldehyde, acetone, diacetyl, formic acid, acetic acid, phenol, para-cresol, pyrocatechol and guiacol. 4. The diacetyl obtained readily yields dimethylglyoxime and the azine, dimethylquinoxaline.

DAVIDSON COLLEGE, N. C.

A CATALOG OF THE BIRDS OF DURHAM COUNTY, NORTH CAROLINA

By Ernest Seeman

Only those species of birds are included herein which have been observed and positively identified in Durham County. While this catalog represents observations made over a period of the past thirty-one years, its incompleteness is nevertheless realized, and the hope expressed that it will prove a useful basis for other observers interested in the ornithology of the region. There are several reasons why such a catalog can only approximate the exact number of species inhabiting a locality. Birds, like human beings, frequently change their habitat; so that species will disappear entirely from a given region and not be seen there again for years—until some favorable factor of food supply or sanctuary may again attract them. Sometimes birds wander outside their natural range, or are blown off their course by storms; and as Durham County is situated midway between mountains and coast, she sometimes entertains feathered delegates from both these realms. Then, too, many kinds of birds that inhabit our state do so for a portion of the year only. The autumn migration sweeps many of our summer forms to lands farther south (Mexico, Cuba, Central and South America), but it brings us others from the north; and some of these remain to winter. The birds of passage begin to reach Durham County on their northward journey during the last week in March, the advance guard (according to migration tables kept for seventeen consecutive years[1]) invariably being chipping sparrows, bluegray gnatcatchers and yellow-throated warblers. A considerable number of these northward-bound species remain to breed; but others press on, some never tarrying until within the Arctic Circle. Some of the migrants common in spring are rare in autumn, and vice-versa: perhaps because they go and come by different routes, or because at one season they loiter, while at another they hasten through.

In some species of birds, certain individuals migrate while others do

[1] Excerpts of these migration tables appear in "Birds of North Carolina," by Pearson and Brimley (published by State Geological Survey, 1919).

not—this habit being characteristic of crows and robins, though not confined to them alone. In summer I have often marked nesting birds with leg-bands to determine whether they would return to the same neighborhood after a flight of a thousand or two miles, and a winter spent in foreign lands. Such individuals often returned and rebuilt (once as long as five years) in the same hollow tree from which I had taken them. This experiment I have tried most satisfactorily with crested flycatchers, and I know of one nesting site which has been occupied by members of that species for more than ten years in succession. I have also known brown thrashers to build in a rose-trellis for a number of years, either building the new nest over the old one, or within a few inches of it, until the vine would be dotted conspicuously with their various homes. In migrating, birds travel almost wholly by night, flying usually at a height of about three miles—where they may be plainly discerned through a telescope as they cross the face of the moon. In foggy weather, however, they are forced to descend very low in order to note the topography of their route; and on any murky night in April or October the sharp-eared observer may distinguish, from dark to dawn, the distinctive piping call by which the travelers keep together. In crossing cities, migrating birds are not infrequently killed by flying into telegraph wires, which accounts for the fact that rare specimens are at this season often picked up in the streets.

The compiling of this catalog began in 1898, and though observations have been made in nearly all parts of the county, the following have been traversed most thoroughly: Eno and Little Rivers (by canoe across the county); Neuse River (by canoe from its headwaters at Alston's Bend to the Wake County line); Flat River (by canoe and trail for the better part of its Durham County length); New Hope Creek (for a fair portion of its course); Ellerbee Creek[2] (intensively in Geer's lowgrounds and Long Trestle Swamp); and the heavily-timbered hill ranges of Mangum and Lebanon Townships.

I am indebted for comparative records and identification of specimens to Dr. T. Gilbert Pearson (whose "Preliminary Catalog of the Birds of Chapel Hill" was published in the *Elisha Mitchell Journal* in 1899),[3]

[2] John Lawson, in his survey of 1701, gives the earliest mention of wild life in this locality as follows: "There is turkey, deere & game in plentie along Ellerbee Creek" (so-called from the Ellerbee Indians).

[3] As Chapel Hill, in Orange County, is only 4 miles distant from the Durham County line, no mention other than the name is made, in this paper, of species recorded by Pearson from that locality.

Messrs. C. S. and H. H. Brimley, and Mr. Ernest Thompson-Seton. Also to Mr. Dave B. Roberts, of Mangum Township, for information concerning the game birds and waterfowl frequenting the Flat River section a half-century ago; and to Mr. J. A. Kellum, warden of Lake Michie (Flat River) and Mr. Pervis Tilley, local observer of waterfowl for the U. S. Department of Agriculture, for a census of the wild ducks now coming in there.

Family PODICIPIDAE

1. **Podilymbus podiceps** (Linn.) Pied-billed Grebe. "Diedapper."

Family LARIDAE

2. **Larus argentatus** (Pont.) Herring Gull. One observed on the reservoir at Hillandale Club in February several years ago, following continued stormy weather. Strictly a sea-bird.

3. **Sterna hirundo** (Linn.) Common Tern. One seen on Lake Michie as a rare wanderer in October 1927, and two on Aug. 2 and 3, 1928. Breeds on the North Carolina coast.

Family PELECANIDAE

4. **Pelecanus occidentalis** (Linn.) Brown Pelican. A half-grown specimen was taken May 29, 1912, by a workman at Erwin's farm, near West Durham. It was shot in the act of swallowing a hen's chicks.

Family ANATIDAE

5. **Lophodytes cucullatus** (Linn.) Hooded Merganser. "Hairy-head." Observed on Lake Michie by Mr. Pervis Tilley. It is to be noted that migrating ducks and geese remain only a short time on the lake, as there are no aquatic plants here on which they may feed.

6. **Aix sponsa** (Linn.) Wood Duck. "Summer Duck."

7. **Nettion carolinense** (Gmel.) Green-winged Teal. A winter visitor. Have flushed these ducks in small numbers in swamps along Ellerbee Creek.

8. **Anas rubripes** (Brewst.) Black Duck. Winter visitor to Lake Michie. Have observed them there in December, and Messrs. Kellum and Tilley report them an irregular winter visitant.

9. **Marila americana** (Eyt.) Redhead Duck. A single bird was observed in the creek at Forest Hills on Jan. 31, 1929, by Mr. W. E. Seeman. Not thus far observed on Lake Michie, either by Mr. Kellum or myself. The range of the species in North Carolina is generally confined to the coastal region.

10. **Anas platyrhynchos** (Linn.) Mallard Duck. This most widely distributed duck of the northern hemisphere has been frequently shot by Mr. Roberts on Flat River during the winters of the past fifty years; and it has also been reported by Messrs. Kellum and Tilley as an irregular winter visitant on Lake Michie at the date of this writing.

11. **Dafila acuta** (Linn.) Pintail Duck. This winter sojourner in the North Carolina coastal region has been a frequent visitor to Lake Michie since its construction two years ago.

12. **Marila valisineria** (Wils.) Canvasback Duck. A rare winter visitor to Lake Michie, though its North Carolina range is generally confined to the coast. A rapidly diminishing species.

13. **Marila marila** (Linn.) Scaup Duck. "Big Blackhead." This species, which as a rule confines its winter range to the vicinity of Pamlico Sound, has been observed on Lake Michie in the winter of 1929 by Mr. Kellum.

14. **Erismatura jamaicensis** (Gmel.) Ruddy Duck. "Sleepy-head." "Lazy Duck." "Bristle-tail." "Butter Duck." This coastal species has been observed by Mr. Kellum on Lake Michie in the winter of 1929. This peculiar "frizzled" looking duck has by its unique appearance won something like sixty different nicknames.

15. **Branta canadensis canadensis** (Linn.) Canada Goose. "Wild Goose." Now rare, but thirty years ago it was a common occurrence to see their wedge-shaped flocks going over in spring

and fall. In the fall of 1928, two birds were seen on Lake Michie by Mr. W. E. Seeman, and during the following winter Mr. Kellum observed a flock of six alight there.

16. **Olor columbianus** (Ord.) Whistling Swan. A small flock observed by Mr. Pervis Tilley on Lake Michie in 1927. This largest of our waterfowl winters in North Carolina, mainly on Currituck Sound.

Family ARDEIDAE

17. **Botaurus lentiginosus** (Montag.) Bittern. "Thunder-pump."

18. **Ardea herodias** (Linn.) Great Blue Heron. "Blue Crane."

19. **Ardea virescens** (Linn.) Green Heron. "Shikepoke."

Family RALLIDAE

20. **Fulica americana** (Gmel.) American Coot. "Blue Peter."

21. **Gallinula galeata galeata** (Licht.) Florida Gallinule. "Red-billed Mud Hen." A rare migrant. Found a dead adult male in the spring of 1915 and a few years later a live immature bird was captured in a marsh near Bilboa by Mr. Hugh Whitted.

Family SCOLOPACIDAE

22. **Philohela minor.** (Gmel.) Woodcock. "Snipe."

23. **Helodramas solitarius solitarius** (Wils.) Solitary Sandpiper.

24. **Actitis macularia** (Linn.) Spotted Sandpiper.

Family CHARADRIIDAE

25. **Oxyechus vociferus vociferus** (Linn.) Killdeer. "Killdee."

Family ODONTOPHORIDAE

26. **Colinus virginianus virginianus** (Linn.) Bob-white. "Quail." "Partridge."

Family MELEAGRIDAE

27. **Meleagris gallapavo silvestris** (Viell.) Wild Turkey.

Family COLUMBIDAE

28. **Zenaidura macroura carolinensis** (Linn.) Mourning Dove. "Turtle Dove."

29. **Ectopistes migratorius** (Linn.) Passenger Pigeon. "Wild Pigeon." As late as 1880 this now extinct species was commonly to be observed as a migrant at Riggs Mountain, Bahama. According to Dave B. Roberts, who hunted them, they were attracted to that locality by the acorns of a dwarf variety of oak. In previous years he has seen them there in such enormous numbers as to break down the branches of trees.

Family CATHARTIDAE

30. **Cathartes aura septentrionalis** (Wils.) Turkey Vulture. "Turkey Buzzard."

31. **Catharista urubu urubu** (Viell.) Black Vulture. "South Carolina Buzzard." (Observed in mid-April; probably breeds.)

Family BUTEONIDAE

32. **Elanoides forficatus** (Linn.) Swallow-tailed Kite. Only one record—two individuals seen on Pamplin's farm, approximately thirty years ago.

33. **Circus hudsonius** (Linn.) Marsh Hawk. "Rabbit Hawk."

34. **Accipiter velox** (Wils.) Sharp-shinned Hawk.

35. **Accipiter cooperi** (Bonap.) Cooper's Hawk.

36. **Buteo borealis borealis** (Gmel.) Red-tailed Hawk. Have found it nesting in Geer's lowgrounds, on Ellerbee Creek. Like his cousin the marsh hawk, he frequents wet meadows, and seems to be content with any kind of game, from spiders to squirrels.

37. **Buteo lineatus lineatus** (Gmel.) Red-shouldered Hawk.

Family FALCONIDAE

38. **Falco sparverius sparverius** (Linn.) Sparrow Hawk.

Family PANDIONIDAE

39. **Pandion haliaetus carolinensis** (Gmel.) American Osprey. "Fish-hawk." "Fish Eagle." Not uncommon on Flat River and New Hope Creek, especially in spring, when fish are running upstream. In the spring of 1927 a nest containing young birds was found on Lake Michie. In addition to fish, I have seen this species capture snakes two feet in length.

Family ALUCONIDAE

40. **Strix pratincola** (Bonap.) Barn Owl. "Monkey-faced Owl." A pair of these birds was accustomed to nest, about twenty-five years ago, in a barn on Pamplin's farm in North Durham. This is my only record, but the species probably still occurs rarely in isolated districts.

Family STRIGIDAE

41. **Strix varia varia** (Barton.) Barred Owl. "Hoot Owl."
42. **Otus asia asia** (Linn.) Screech Owl.
43. **Bubo virginianus virginianus** (Gmel.) Great Horned Owl.

Family CUCULIDAE

44. **Coccyzus americanus americanus** (Linn.) Yellow-billed Cuckoo. "Rain Crow."

Family ALCEDINIDAE

45. **Ceryle alcyon alcyon** (Linn.) Belted Kingfisher.

Family PICIDAE

46. **Dryobates pubescens pubescens** (Linn.) Southern Downy Woodpecker. A resident. His sudden, piping note is a common call of the woodlands.

47. **Dryobates villosus audubonii** (Swains.) Southern Hairy Woodpecker. Not uncommon in winter; probably breeds.

48. **Melanerpes erythrocephalus** (Linn.) Red-headed Woodpecker.

49. **Phlaetomus pileatus** (Linn.) Pileated Woodpecker. "Log Cock."

50. **Sphyrapicus varius varius** (Linn.) Yellow-bellied Sapsucker. "Yankee Sapsucker."

51. **Colaptes auratus** (Linn.) Flicker. "Yellow-hammer."

Family CAPRIMULGIDAE

52. **Antrostomus vociferus vociferus** (Wils.) Whip-poor-will.

53. **Choirdeiles virginianus virginianus** (Gmel.) Nighthawk. "Bull-bat." "Mosquito Hawk."

Family MICROPODIDAE

54. **Chaetura pelagica** (Linn.) Chimney Swift. "Chimney Swallow."

Family TROCHILIDAE

55. **Archilochus colubris** (Linn.) Ruby-throated Hummingbird.

Family TYRANNIDAE

56. **Tyrannus tyrannus** (Linn.) Kingbird. "Bee Martin."

57. **Myiarchus crinitus** (Linn.) Crested Flycatcher.

58. **Sayornis phoebe** (Lath.) Phoebe.

59. **Myiochanes virens** (Linn.) Wood Pewee. Pewee.

60. **Empidonax virescens** (Viell.) Acadian Flycatcher.

Family CORVIDAE

61. **Cyanocitta cristata cristata** (Linn.) Blue Jay. "Jay-bird."

62. **Corvus brachyrhynchos brachyrhynchos** (Brehm.) Crow.

63. **Agelaius phoeniceus phoeniceus** (Linn.) Red-winged Blackbird.

64. **Sturnella magna magna** (Linn.) Meadowlark. "Field Lark." (Found breeding at Camp Sacarusa on Eno River in June.)

65. **Icterus spurius** (Linn.) Orchard Oriole. (Found breeding at Camp Sacarusa in June.)

66. **Icterus galbula** (Linn.) Baltimore Oriole. A rare transient. Only one record, May 8, 1902.

67. **Euphagus carolinus** (Mull.) Rusty Blackbird.

68. **Quiscalus quiscula quiscula** (Linn.) Purple Grackle.

69. **Dolichonyx oryzivorus** (Linn.) Bobolink. "Ricebird."

Family STURNIDAE

70. **Sturnus vulgaris** (Linn.) Starling. An abundant resident, although it first penetrated this region less than ten years ago. In 1905 Dr. Frank M. Chapman, at the American Museum of Natural History in New York City, pointed out to me his colony of starlings, derived from the first introduced into Central Park by Eugene Schieffelin from Europe fifteen years before. At that time they had only spread to the outskirts of New York City; but twenty-four years later this hardy species has spread over the entire eastern United States and to a considerable distance westward.

Family FRINGILLIDAE

71. **Carpodacus purpureus purpureus** (Gmel.) Purple Finch.

72. **Passer domesticus domesticus** (Linn.) English Sparrow.

73. **Astragalinus tristis tristis** (Linn.) Goldfinch.

74. **Pooecetes gramineus gramineus** (Gmel.) Vesper Sparrow. "Bay-winged Bunting." (Found summering here June 30, 1929.)

75. **Ammodramus savannarum australis** (Mayn.) Grasshopper Sparrow.

76. **Passerculus sandwichensis savanna** (Wils.) Savannah Sparrow.

77. **Peucaea aestivalis bachmani** (Aud.) Bachman's Sparrow.

78. **Zonotrichia albicollis** (Gmel.) White-throated Sparrow.

79. **Spizella passerina passerina** (Bechst.) Chipping Sparrow. "Tip Sparrow."

80. **Spizella pusilla pusilla** (Wils.) Field Sparrow.

81. **Junco hyemalis hyemalis** (Linn.) Slate-colored Junco. Snowbird.

82. **Melospiza melodia melodia** (Wils.) Song Sparrow.

83. **Melospiza georgiana** (Lath.) Swamp sparrow.

84. **Passerella iliaca iliaca** (Merr.) Fox Sparrow.

85. **Pipilio erythropythalmus erythrophthalmus** (Linn.) Towhee. "Chewink." "Ground Robin." (Observed in the highlands at Bahama in late May; probably breeds there, rarely.)

86. **Cardinalis cardinalis cardinalis** (Linn.) Cardinal. Red-bird.

87. **Guiraca caerulea caerulea** (Linn.) Blue Grosbeak.

88. **Passerina cyanea** (Linn.) Indigo Bunting. "Indigo Bird."

Family TANAGRIDAE

89. **Piranga erythromelas** (Viell.) Scarlet Tanager. (Found breeding on Flat River, July 28, 1929.)

90. **Piranga rubra rubra** (Linn.) Summer Tanager. "Summer Redbird." "Peterchuck."

Family HIRUNDINIDAE

91. **Progne subis subis** (Linn.) Purple Martin.

92. **Hirundo erythrogastra** (Bodd.) Barn Swallow.

93. **Iridoprocne bicolor** (Viell.) Tree Swallow. "White-bellied Swallow."

94. **Steligedopteryx serrepennis** (And.) Rough-winged Swallow.

Family BOMBYCILLIDAE

95. **Bombycilla cedrorum** (Viell.) Cedar Waxwing. "Cedarbird." "Cherrybird."

Family LANIIDAE

96. **Lanius ludovicianus migrans** (Palmer.) Migrant Shrike. Uncommon winter visitor. Also known as "butcher bird," from its habit of impaling mice and grasshoppers on thorns.

Family VIREONIDAE

97. **Vireosylva olivacea** (Linn.) Red-eyed Vireo. "Little Hanger."

98. **Lanivireo flavifrons** (Viell.) Yellow-throated Vireo. "Big Hanger."

99. **Vireo grisens grisens** (Bodd.) White-eyed Vireo.

100. **Lanivireo solitarius solitarius** (Wils.) Blue-headed Vireo.

Family MNIOTILTIDAE

101. **Mniotilta varia** (Linn.) Black-and-white Creeping Warbler.

102. **Compsothlypis americana americana** (Linn.) Parula Warbler.

103. **Dendroica aestiva** (Gmel.) Yellow Warbler. "Summer Yellowbird."

104. **Dendroica caerulescens caerulescens** (Gmel.) Black-throated Blue Warbler.

105. **Dendroica coronata** (Linn.) Myrtle Warbler. "Yellow-rumped Warbler."

106. **Dendroica pennsylvanica** (Linn.) Chestnut-sided Warbler.

107. **Dendroica striata** (Forst.) Black-poll Warbler.

108. **Dendroica fosea** (Mull.) Blackburnian Warbler.

109. **Dendroica dominica dominica** (Linn.) Yellow-throated Warbler.

110. **Dendroica virens** (Gmel.) Black-throated Green Warbler.

111. **Dendroica vigorsi vigorsi** (Aud.) Pine Warbler.

112. **Dendroica palmarum hypocrysea** (Ridgw.) Yellow Palm Warbler. Erratic spring migrant; sometimes not seen for years and then suddenly coming through in considerable flocks.

113. **Dendroica discolor** (Viell.) Prairie Warbler.

114. **Seiurus aurocapillus** (Linn.) Oven Bird. "Golden-crowned Thrush."

115. **Seiurus noveboracensis noveboracensis** (Gmel.) Water Thrush.

116. **Seiurus motacilla** (Viell.) Louisiana Water Thrush.

117. **Geothlypis trichas trichas** (Linn.) Maryland Yellow-throat.

118. **Opornis formosus** (Wils.) Kentucky Warbler. Not uncommon as a summer resident. Have found nests in low bushes on hillsides adjoining small streams.

119. **Icteria virens virens** (Linn.) Yellow-breasted Chat. "Pompey."

120. **Wilsonia citrina** (Bodd.) Hooded Warbler.

121. **Setophaga ruticulla** (Linn.) Redstart.

Family MOTICILLIDAE

122. **Anthus rubescens** (Tunst.) Pipit. "Titlark."

Family MIMIDAE

123. **Mimus polyglottos polyglottos** (Linn.) Mockingbird.

124. **Dumetella carolinensis** (Linn.) Catbird.

125. **Toxostoma rufum** (Linn.) Brown Thrasher.

Family TROGLODYTIDAE

126. **Thryothorus ludovicianus ludovicianus** (Lath.) Carolina Wren.

127. **Throglodytes aedon aedon** (Viell.) House Wren.

128. **Hannus hiemalis hiemalis** (Viell.) Winter Wren.

Family CERTHIDAE

129. **Certhia familiar americana** (Bonop.) Brown Creeper.

Family SITTIDAE

130. **Sitta carolinensis carolinensis** (Lath.) White-breasted Nuthatch.

131. **Sitta pusilla** (Lath.) Brown-headed Nuthatch.

132. **Sitta canadensis** (Linn.) Red-breasted Nuthatch. This inhabitant of the far north (and rarely of the forests of western N. C.) in extreme winters is sometimes an uncommon visitor. Its chief food is pine seeds.

Family PARIDAE

133. **Baeolophus bicolor** (Linn.) Tufted Titmouse. "Peto Bird."

134. **Penthestes carolinensis carolinensis** (Aud.) Carolina Chicadee.

Family SYLVIIDAE

135. **Regulus satrapa satrapa** (Litcht.) Golden-crowned Kinglet.

136. **Regulus calendula calendula** (Linn.) Ruby-crowned Kinglet.

137. **Polioptila caerulea caerulea** (Linn.) Blue-gray Gnatcatcher; "Moss Bird."

Family TURDIDAE

138. **Hylocichla mustelina** (Gmel.) Wood Thrush. "Swamp Robin;" "Quillaree."

139. **Hylocichla guttata pallasi** (Cab.) Hermit Thrush.

140. **Hylocichla forcescens forcescens** (Steph.) Veery Thrush. A rare transient. Only one record.

141. **Planesticus migratorius migratorius** (Linn.) Robin.

142. **Planesticus migratorius achrusterus** (Batch.) Southern Robin. This is an extreme southern variety of the robin, being smaller and lighter-colored than the original species. Commonly breeds here along with its cousin, but seems to be especially partial to lawns and gardens.

143. **Sialia sialia sialia** (Linn.) Bluebird.

DURHAM, N. C.

NOTES ON FUNGI[1]

By W. C. Coker

Hygrophorus Ravenelii B. & C.

Frontispiece and plates 10 and 23

Cap 4–6.5 cm., campanulate and strongly pointed, umbonate, glabrous, glutinous, striatulate when moist, color wax to cadmium yellow on margin, the center deepening through orange to nearly scarlet on the umbo or the more intense central color may be only orange or pale orange (the general effect of the cap color is yellow tinged with red). Flesh brittle and fragile and very thin, about 2 mm. thick near the center, yellow or under the cuticle orange; tasteless and odorless.

Gills rather close, then at maturity not close (never distant), thin, broad, up to 8–9 mm., rounded at stem and usually only narrowly adnexed, the margins uneven; color a clear wax yellow.

Stem long, 6–14.5 cm., 6–9 mm. thick, nearly equal, glabrous, shining, slightly viscid (not glutinous), color of gills or a little darker above, shading to pure white on the lower third; when bruised turning smoky brown, then almost black after hours. Structure very fibrous, lightly stuffed, then hollow, the fibers easily splitting.

Spores (of No. 3590, print) smooth, elliptic, extremely variable in size in the same plant, 5–8 x 8.5–14μ. Basidia clavate, 2-spored, 7–9.3 x 27–35μ, counting the sterigmata which are about 5μ long.

On exposure to air in the laboratory, the colors of all parts become more intense, the cap becomes more red, the gills and stem a deeper yellow.

The *Hygrophorus* group in which this plant is included is an extremely variable and complicated one. No description fits our plant perfectly, but it seems rather clear that it is *Ravenelii* B. & C. (Ann. Mag. Nat. Hist. II, **12**: 424. 1853), which is a southern plant from the same kind of habitat. The original description, which is about all that is known

[1] The material studied in this article was collected by W. C. Coker, H. R. Totten, J. N. Couch, and Alma Holland.

PLATE 10

HYGROPHORUS RAVENELII. No. 3590

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about it, fits our plant as well as or better than any other, the only differences being that the stem is described as attenuated below and no mention is made of its blackening. The stem is variable at the base and our plate shows the extreme of enlargement below; some are equal or slightly attenuate. The blackening would be easily overlooked unless specially attended to. *Hygrophorus Langei* Dodge (Rhodora **29:** 238. 1928; *H. constans* Lange) agrees very closely except for smaller size and that no mention is made of the stem turning black when bruised. The species is said to be distinguished from *conicus* chiefly by never turning black. This is essentially true of our plants which in the dried state are bright yellowish tan all over except on badly bruised portions of the stem, a very sharp distinction from *conicus* which is black all over when dry. *Conicus* differs also, according to our interpretation, in generally smaller size, greater mixture of colors in the same plant, and grayish tint of the gills. *Hygrophorus tristis* Pers. as understood by Bresadola is also very near and has the stem blackening (Icon. Myc. VII: pl. 349), but that has 4-spored basidia and the gills are shown with regular edges. Moreover, *tristis* is shown, in the figures Persoon refers to, as blackening in all parts. Except for blackening quickly in all parts and 4-spored basidia, *H. pseudo-conica* Lange represents our plant well.

We are publishing herewith a photograph by Prof. Beardslee of *H. calyptraeformis* B. & Br. (*H. amoenus* Lasch) from Asheville, N. C. He shows plants absolutely identical with ours except for color and perhaps in the stem not blackening. One of his three plants on plate 12 shows a blackened area on the stem, but in a letter to us Beardslee says he has not noticed any blackening. It may also be noted that Cooke reports from England a pure white variety of *calyptraeformis* (Rea, Brit. Basid., p. 308). We do not know of any previous report of *calyptraeformis* from this country (for Beardslee's description see p. 167).

We have found a plant which we take to be *H. cuspidatus* Pk., a closely related plant so far reported only from the original locality in Canada. Beardslee has also found a plant in Canada which he takes to be this species. It may be just a form of what we are calling *Ravenelii*, but it is smaller, more permanently conical like *conicus*, and the stem does not turn black. The gills too are much narrower and less irregular. We give below a description of our *H. cuspidatus*.

It is our opinion that all these plants are races of one species, which differ from *conicus* in the respects above mentioned. Analogous cases of color races are *Amanitopsis vaginata* and *Mycena pura*. As to the 2-spored basidia, it is likely that this is of little consequence in separating

species, as there is much variation in this respect in this group. While predominantly 2-spored, there are apparently 4-spored races (Bauch, Zeitsch. für Bot. **18:** 342; Gaumann and Dodge, Comp. Morph., p. 456). Bauch studies cytologically a 2-spored and a 4-spored race of *H. virgineus*. Lange finds growing close together a 2-spored and a 4-spored group of *H. Reai* (Dansk Bot. Arkiv. **4:** 12. 1923). Typical *conicus* is said to be 2-spored both in Europe (Lange) and in America (Buller).

We have four collections from damp, mixed or coniferous woods, all found in November.

Hygrophorus cuspidatus Peck.

Plate 11

Cap 2.5 cm. broad, strongly conical when young and with a very sharp pointed or rounded umbo, expanding but still flatly conic when mature, and sharply mucronate or with a rounded umbo, surface viscid, smooth, shining, the edge crimped when young, more or less irregularly lobed at maturity, color a deep orange-red all over or yellowish at any point. Flesh 1 mm. thick near stem, reddish above, pure white or yellow below, not turning dark when bruised.

Gills a rather light but clear yellow all over, barely attached, 3 mm. wide in middle, pointed at both ends, not veined at cap.

Stem not viscid, 4–5 cm. long, 4–5 mm. thick, nearly even or slightly largest below, smooth, shining, orange-red or orange-yellow above, becoming lighter and more yellow downwards, *white at the base*, flesh fibrous, color of surface in outer half, pure white inside, hollow, the hollow running into the cap and broadening out into a little chamber which is yellow granular on the inside exactly like *H. conicus*.

Spores oblong-elliptic, smooth, 5.5–7 x 9–12μ.

This peculiar plant is shaped exactly like *H. conicus*. In the three plants collected, two had small sharp mucros at the tip of the cone when young and were abruptly mucronate when mature; the other was just as conic but with a rounded umbo. The three plants were undoubtedly the same species, as they were growing in a group and were identical in every other way. They did not turn at all dark when bruised. In the same woods at the same time were found typical plants of *H. conicus*, with its gray gills and peculiar cap colors, quickly turning to black.

1742. Low, damp, shaded place at foot of Lone Pine Hill, September 12, 1915.

PLATE 11

HYGROPHORUS CUSPIDATUS. No. 1742

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Hygrophorus calyptraeformis Berk.

Plate 12

The following description is by Prof. H. C. Beardslee.

Cap 3–8 cm. broad, at first acute conic, then expanded with the margin splitting and reflexed and a sharp conspicuous umbo, viscid, fragile and easily breaking, a beautiful clear rose color, never blackening.

Gills clear rose, rather distant, ventricose, unequal in length and breadth, narrowed behind and slightly adnexed.

Stem 6–10 cm. long, 8–10 mm. thick, nearly equal, fragile, hollow, white or rose tinted but paler than the cap, not blackening when handled.

This is the most beautiful *Hygrophorus* I have seen. It seems rare and in my collecting grounds is limited to one small area. I find it each year from the last of July on through August in deep shade along a small ravine. In form it is not unlike *H. conicus*, but it never blackens with age, and the color is entirely different. Cooke's figure exactly represents our plant except that the color in ours is brighter.

Asheville, N. C. Nos. 931 and 16119.

Hygrophorus sciophanus Fr.

Plates 13 and 23

Cap 1.5–2.5 cm. broad, umbonate, plane or convex at maturity, glutinous, hygrophanous, dull watery reddish orange and striatulate with color when wet, a much paler pinkish rose or yellowish pink when dry; margin somewhat crenated. Flesh pale orange, nearly white when dry, about 1 mm. thick at center, odorless and tasteless.

Gills distant, adnate or sinuate-adnexed, 2–2.5 mm. broad, ventricose, interveined, a beautiful orange red at all ages, about bitter-sweet orange of Ridgway but richer.

Stem about 2.5–4 cm. long, 2–3.5 mm. thick, equal, glutinous, often flattened, quite smooth all over, stuffed then hollow, color of cap.

Spores ovate-elliptic to tear-shaped, smooth, with a large mucro, 3.7–4.4 x 6.6–8μ.

Easily distinguished by its beautiful gills, the margins *not* darker, and by the glutinous cap and stem, the latter quite glabrous above as well as below.

This species has not been recognized heretofore in this country. It agrees in all essentials with European descriptions and is well represented by Bresadola's plate 339 (Icon. Myc. **7**) and by Fries's plate 167, fig. 1 (Icon. Selectae).

2791. In mossy grass, July 27, 1917.

Hygrophorus gomphidioides n. sp.

Plates 14 and 23

Cap 1.5–2.8 cm. broad, center strongly depressed, the margin curved and drooping, surface slightly viscid, distinctly fibrous, the fibers separated and inherent to form interrupted radial grooves, the tips pinched up to form small, scattered, punctate squamules. Color about cinnamon—rufous to tawny or darker when soaked in age. Flesh tender, but not brittle, concolorous but paler, about 1.5 mm. thick near stem; odor none, taste distinctly and persistently bitter-astringent.

Gills rather close, sub-decurrent, 2–3 mm. broad, thick, waxy, veined, a deep rich chestnut or mahogany brown, slightly glaucous from the spores, margins blunt and more or less uneven.

Stem 1.5–3 cm. long, 3–6 mm. thick, smooth all over, usually flattened and channelled, crooked, sub-equal or tapering downward, about color of cap, the base usually constricted and slightly inserted; very hollow; flesh fibrous, easily splitting.

Spores (print) white, oval or short-elliptic, smooth, 3.8–5 x 5.5–8μ.

The plant in form and color looks much like a small *Gomphidius*.

It seems to fall in the *miniatus-cantharellus* group, but it is not very close to any of these. It is a very peculiar and well marked species, sharply distinguished by the conspicuously radiating fibrous lines on the cap, ending in delicate squamules, strongly depressed, *Gomphidius*-like shape of the cap, and the distinctive colors. The spores are smaller than others of the group.

4248. Mixed woods, damp, rocky, sandy soil near Meeting of the Waters, April 15, 1920.

Hygrophorus luridus B & C

Frontispiece and plate 23

Cap 1.4–2.4 cm. broad, convex at all ages, striatulate and blackish when young with margin incurved, shallowly striate when mature, surface shining with gluten at all ages, very viscid, gray brown, a deep drab with yellowish drab tints. Flesh nearly white, tasteless and odorless, thin.

Gills distant, broad (4–5.5 mm.), notched, decurrent by a tooth, rather thin, gray when young, very pale gray when mature.

HYGROPHORUS CALYPTRAEFORMIS. ASHEVILLE, N. C. Photograph by Beardslee

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Stem 2.5–3 cm. long, 2–4 mm. thick, nearly equal or tapering a little below, pale sepia at all ages or darker below in age, shiny and glutinous, glabrous, hollow.

Spores oval, about 4–5 x 6.6–7μ.

Our plants have been compared by Dr. J. N. Couch with Curtis's co-type in his herbarium at Cambridge. Thanks are due Dr. W. H. Weston for placing the herbarium at his disposal. Curtis's plants have the same appearance as ours and the spores agree well. They are smooth, oval, 4.2–5.5 x 5.5–6.7μ. Aside from the original collection in South Carolina, the species has been found heretofore only in Massachusetts and New York. I tried this summer to compare our plants with the types of *H. Davisii* Pk., which seems very near. Dr. House kindly helped me look for the types, but they could not be found.

3353. In grassy place by ditch, June 13, 1919.

3472. In damp mossy soil, August 17, 1919. This agrees with No. 3353 in spores and other respects except that it is distinctly umbonate and has rather longer stem.

7332. Damp leafy mold, July 7, 1924. Spores oval, smooth, 4–5.5 x 5–7.4μ.

Tricholoma niveipes Pk. var. **australis** n. var.

Frontispiece and plate 23

Cap up to 7 cm. broad, brokenly and roughly expanded, drooping slightly at the irregular and deeply lobed margin; smooth, not viscid, blackish gray. Flesh pale gray, not brittle; odorless and tasteless.

Gills close, unbranched, about 6 mm. wide, broadly notched at stem, very pale gray.

Stem crooked, smooth, hollow, on average about 5 cm. long and 15 mm. broad, tapering downward to an enlarged rounded base which is buried in the soil; not viscid, pale grayish, and slightly punctate-fibrous.

Spores smooth, of peculiar shape, rod-elliptic, some a little bent, much like the spores of many Clavarias, 2.5–3 x 7.5–9μ.

Compared at Albany and found to be *Tricholoma niveipes* Pk. which has same spores, same size and shape, about same color and grows in sand under pines. The pale gray gills, somewhat darker cap, and gills not so yellow in dry state indicate a varietal difference.

76. Hartsville, S. C., in sandy pine woods, December 26, 1918

Collybia lentinoides Pk.

Plates 15 and 23

Cap 2.1–3 cm. broad, broadly convex, glabrous, hygrophanous, moderately viscid, light pinkish buff when damp, a clearer buff when not soaked, striatulate when damp, center not wrinkled, at times a little depressed. Flesh whitish (pale, concolorous) about 2–2.5 mm. thick in center, brittle, odor and taste of radish or turnip, not acrid.

Gills rather close, broadly notched at stem, up to 5.5 mm. wide, nearly white, then pale pink in age, withering brownish, veined, margins uneven.

Stem 2.8–4.5 cm. long, 2.5–5 mm. thick, glabrous, faintly granular above, nearly equal, fibrous, not brittle, very hollow even before grown, whitish or concolorous below, hairy at the protected base. The stem is not viscid, or very faintly so and there is no glutinous veil.

Spores white, smooth, elliptic, 3.3–4 x 5.5–7.5μ. Hyphae of gill trama parallel. Basidia 4-spored, about 11μ thick, sterigmata about 3.5μ long.

Reported heretofore from New York, Massachusetts and Michigan.

3755. Lowground pasture, pine woods, November 15, 1919.

Omphalia lilacifolia Pk.

Frontispiece and plate 23

Cap 0.8–2.5 cm. broad, hemispheric when very young, then convex and strongly umbilicate, hygrophanous, glabrous, striatulate when moist, in youth slimy and deep olive green, then quickly tawny green or bright yellow or grayish yellow, becoming a dull soaked tawny and viscid, with the margin often distinctly olivaceous. Flesh 1 mm. thick in center, concolorous, tender and rather brittle, fibrous; odor slight, taste mild.

Gills not crowded, up to 3 mm. wide, arcuate, decurrent, waxy, not veined, the blunt margin even, color a pretty pale lilac which fades to a pale, soaked clay color with a faint tint of lavender.

Stem 1.5–3.5 cm. long, 1.5–2.5 mm. thick, equal, concolorous with cap or lilac at each end and yellowish in the middle, viscid, quite glabrous all over, texture fibrous, at first stuffed, then hollow, the base with a beautiful little mat or boot of woven clear lavender threads, and the mycelium as it disappears into the wood is also lavender. In the herbarium the mycelium fades to pale tan.

PLATE 13

HYGROPHORUS SCIOPHANUS. No. 2791

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Spores (of No. 3557) white, smooth, elliptic, 3.5–4 x 5.7–7.4μ, with a long mucro.

A remarkable and beautiful plant which has not been recorded heretofore except from New York and Michigan. It is easily distinguished by the lavender stem mat and mycelium, lavender tinted gills, greenish then tawny cap and stem and glutinous envelope. There is no glutinous ring left on stem and the gluten extends from cap margin to stem only in my young plants in which the cap is smaller than a pin head.

Illustration: Peck. N. Y. St. Mus. Rept. **24:** pl. 1, figs. 10–13. 1872.

3016. On a pine stump, April 23, 1918.
3022. On a pine stump, April 23, 1918. Spores 3–3.8 x 5–7μ.
3557. On a decaying pine stump, October 31, 1919.

Prunulus syringeus Murrill.

Frontispiece and plates 16 and 23

Cap 5–20 mm. broad, hemispheric then convex or nearly plane and with or without a small umbo, smooth to minutely silky-felted, dry or slightly viscid, pinkish violet in youth, becoming creamy violet or a pretty lilac purple all over or with the center yellowish at maturity, not striate. Flesh thin, about 0.5 mm., delicate, brittle, color of cap or paler, tasteless and odorless or with a slight odor of grapes.

Gills color of cap or lighter, thick, moderately distant, ventricose or broadest near the stem, where they may be up to 2.5 mm., deeply and abruptly sinuate and narrowly adnexed.

Stem 2–3 cm. long, 1–2.5 mm. thick, equal, crooked, granular scurfy above or all over, color of cap above, fading to whitish or creamy tan below, the base for about 5 mm. decorated with thick white or faintly purplish strands which run for some distance in the leaves; flesh concolorous with the surface, brittle, with a small central cylinder which is lightly stuffed or hollow.

Spores (of No. 3474) white, smooth, subspherical, 2.6–3.2 x 3.7–4μ.

A pretty little species easily recognized by its violet color, coarse mycelial strands, and minute spores. We are referring it to *P. syringeus* Murrill (N. Amer. Flora **9:** 341) from Jamaica, a plant known heretofore only from the type collection, because the description agrees well in every detail except that the gills are described as adnate and no mention is made of the mycelial strands at the base of the stem. It is dis-

tinguished from *Mycena pura* by smaller size, minute spores, and absence of radish taste.

We have seven collections made around Chapel Hill during July and August. Its favorite habitat is damp woods among rotten leaves and moss, and it occurs in both coniferous and deciduous woods.

Marasmius albiceps Pk.

Plates 14 and 23

Cap 2–5 mm. broad, hemispheric to conic-campanulate, striate or sulcate to near the flat or slightly depressed center, glabrous, dull white when quite fresh or with only the center brownish or with brown areas at any place.

Gills distant, white, arcuate, broader than long and long-decurrent.

Stem 2–4 cm. long, hair-like, glabrous, shining black except for the whitish top, tough, attached at the base by numerous long brown hairs.

Spores (of No. 3382) smooth, elliptic, 3.4–4 x 6–9μ.

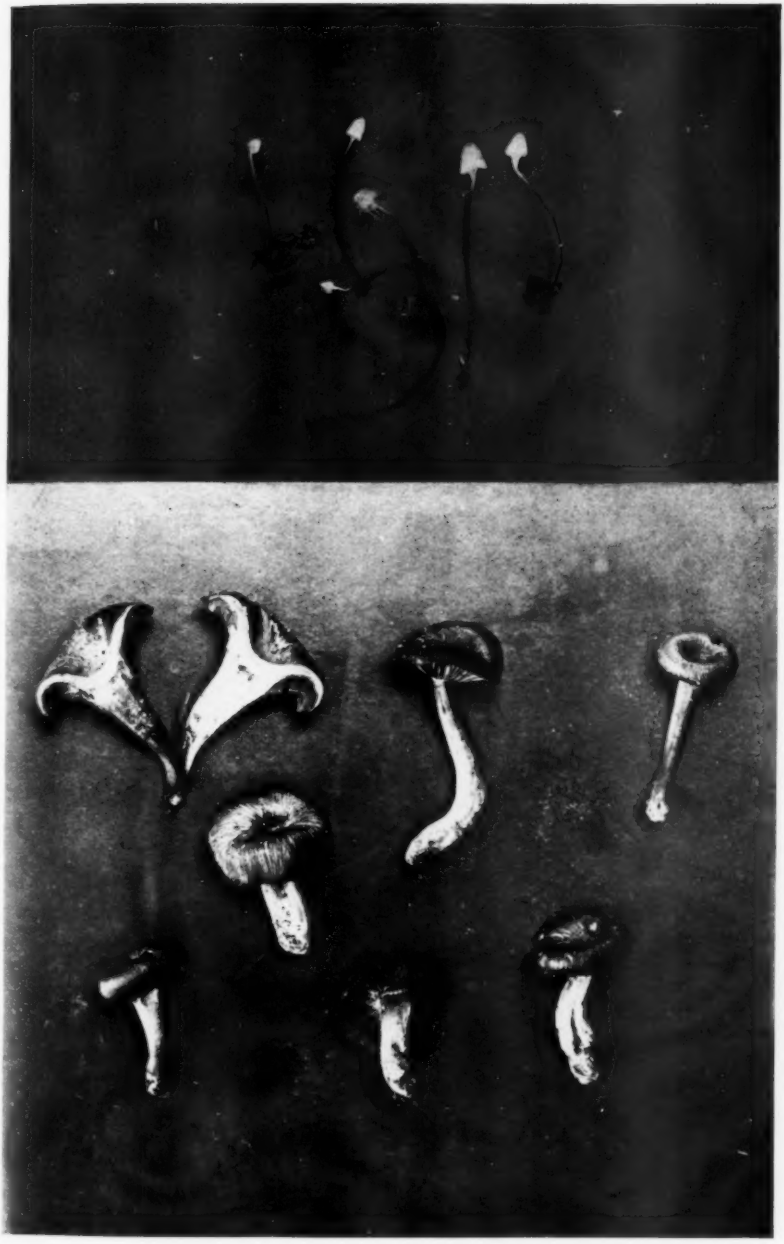
Easily recognized by the *Omphalia*-like gills, small size and white topped stem with brown mycelium. Reported heretofore only from New York and Michigan. *Omphalia gracillima* is much like this in size, shape, gills, etc. but that has a white stem (see Mycologia **9:** 32, pl. 4. 1917).

Our plants differ from the type only in not having the cap pure white.

2742. On oak leaves, July 21, 1917.
3382. On oak leaves, June 28, 1919.
3514. On damp decaying leaves, October 25, 1919. Spores variable in size, 3–5 x 7.4–8.5μ.

Clitocybe pinophila, fragrant form.

Under cedars on a hillside we have found a peculiar form of what we are taking to be *C. pinophila.* It had when fresh a distinct odor of anise, concentric wrinkles on the cap, and spores only 2–3 x 3.7–4.5μ. In the dried state it looks exactly like *pinophila,* and the spores of the latter seem quite variable (see Journ. E. M. Sci. Soc. **38:** 122). The plants differ easily from *odora* and its variety *anisaria* in much smaller size, quite glabrous cap, and smaller spores.



MARASMIUS ALBICEPS. NO. 2742 (ABOVE)
HYGROPHORUS GOMPHIDIOIDES. NO. 4248 (BELOW)

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Lentinus Micheneri B. & C.

Frontispiece and plates 17 and 23

Cap 1.5–4.6 cm. broad, hygrophanous, strongly umbilicate but not broadly so, the margin expanded and usually slightly drooping, surface perfectly smooth all over at all ages and dully shining, not fibrous or streaked or striate, margin irregular, lobed, often finely denticulate; color of cap a dull, soaked slightly pinkish tan all over at all ages, paler when not soaked and the center at times darker. Flesh color of cap, tough, about 0.8 mm. thick throughout except extreme margin, strongly peppery or only mildly so.

Gills rather close, not densely crowded, many short, some forked, only slightly decurrent and some sinuate at stem, about 3–5 mm. wide, the margin strongly set with long, irregular teeth, i.e., very strongly serrate-lacerate; color whitish, tinted with the cap color.

Stem up to 4 cm. long, the largest flattened and 2–4 mm. thick, others round and smaller, surface pruinose, and often with ascending lines of spongy tomentum from the base, rugose-wrinkled longitudinally downward, the base for some distance enlarged and strongly attached to the wood by the dense, tawny mycelium; color very deep brown below, fading gradually upward to the somewhat lighter top. Texture very tough, but not so hard as in some species of this genus, the center stuffed or with a small hollow.

Spores (of No. 3527) pure white, oval or subspherical, smooth, 3.3–4 x 4–5μ.

On drying the plant becomes much lighter in color and can be completely revived in a damp chamber.

Lentinus Micheneri has not been reported except by the older mycologists (Michener, Curtis), and is placed by Murrill in the doubtful species. The type was from Pennsylvania and Dr. Carroll W. Dodge has very kindly confirmed our determination by comparison of our plants with originals in the Curtis Herbarium (Michener, No. 980, sent Berkeley as No. 3962, co-type; Alabama, Peters, No. 1287). Curtis lists it from North Carolina. *Lentinus omphalodes* from Europe and *L. umbilicatus* Peck (Murrill considers these the same) differ conspicuously from *Micheneri* in the glabrous, even or much less wrinkled stem, and growth on ground. The spores of the former are said to be rough; of the latter, smooth (Kauffman). *Lentinus americanus* differs in even stem, agreeable taste, apricot odor, and growth on ground. *Lentinus bisus* (see Bresadola, Fungi Trid., p. 12, pl. 12) of Europe is also in this group

but differs in the same respects as *omphalodes* does, i.e., in rough spores, glabrous stem, and lack of basal pad. The basal pad, together with the pruinose to spongy stem above the pad, is the most conspicuous feature of *L. Micheneri*, and separates it from all its relatives.

We have five collections on oak or hickory, June to November.

Pholiota terrigena Fr.

Plates 18 and 23

Cespitose on the ground in groups in considerable numbers (3–8) or some solitary. Cap 3–5.7 cm. broad, convex, then fully expanded with irregular and usually undulate margin. Color when young pale whitish straw with rather small flocculent squamules, becoming yellowish straw color with center in some cases distinctly primuline yellow, the squamules thin, appressed-fibrous; surface between the squamules paler and shining; surface moderately viscid. Flesh soft, very thin (3–6 mm. at stem), nearly white, soon turning yellow when cut. Odor of radish, but taste not noticeable.

Gills pale clay then honey yellow, broadly sinuate, about 5 mm. wide, close, margin even and not whitish. Veil very delicate, almost cobwebby, remaining as little pendants on the margin and flocculent fibers on the stem, nearly white at first except for outer fibers which are yellowish.

Stem hollow, about 3.5–5 cm. long, 7–9 mm. thick, nearly equal, but at times irregular and pinched in places, whitish but with soft yellowish to brownish squamules below the veil attachment which is about 3–6 mm. below the cap, nearly glabrous above the veil threads, slightly viscid. Mycelium white, obvious on surface of the ground.

Spores cinnamon brown, oval, smooth, 3.5–4.4 x 5.4–6.8μ.

This terrestrial species seems certainly the American representative of *terrigenus* Fries. Cooke's plate 349 agrees almost perfectly with our plants except that the squamules are less conspicuous in his plate. *Pholiota terrestris*, as described by Overholts, differs in the presence of an ample and membranous veil and different color of cap. It is known only from Oregon unless Harper's *terrigena* from Wisconsin (Trans. Wis. Acad. **17:** 484, pl. 33. 1912) is the same, as Overholts supposes. If Harper's record is really referable to *terrestris*, then this is the only known occurrence of *terrigena* in America. The spores from a spore print are very variable in our plants and cover the dimensions as given by Overholts for both *terrestris* and *terrigena*. The plant is distinguished

by its growth on soil, delicate appearance, yellow color, absence of a distinct veil, and squarrose fibers on the stem which collapse in age.

8364. On ground in grass by Davie Hall, October 11, 1928.

Pluteolus intermedius n. sp.

Plates 19 and 23

Delicate and fragile, solitary. Cap 3–4.5 cm. broad, regular, when mature expanded or shallowly funnel-form, the very center elevated as a low rounded umbo, viscid when damp; color about wood brown, the center darker to nearly blackish; strongly striate-plicatulate, the center with rugulose radiations around the umbo. Flesh membranous, very thin and delicate.

Gills about 2 mm. wide, close, nearly free, about cinnamon (Sayal brown, Ridgway) at maturity.

Stem 4–6 cm. long, 2.5–4 mm. thick in center, tapering upward, delicately granular in lines, white above and below, citron yellow in middle region, lightly stuffed, then hollow; flesh color of surface.

Spores cinnamon, ovate-elliptic, often with one side slightly flattened, 4.5–6 x 9–11.5μ. Basidia 4-spored, separated by sterile cells, looking very much like *Coprinus* in surface view (see Buller's Researches in Fungi **1:** pl. 3, fig. 15).

This beautiful little plant combines to a peculiar degree some of the most striking characteristics of *Pluteolus reticulatus* and *P. expansus*. The blackish umbo with glutinous reticulations is exactly as described for the former. The deeply sulcate-plicate cap and yellow stem are characters of *expansus*. As *expansus* may grow on the ground, it agrees with that species in this respect also. The colors of the cap do not agree with either species but are nearer those of *expansus*. The spores are exactly those of *reticulatus*, as given by Kauffman, and are narrower than those of *expansus*.

8365. By branch in woods in Battle's Park, October 19, 1928.

Stereum elegans Meyer.

Plates 20 and 23

Plants single or more often in close groups with free stems and fused lobes. Caps expanding in all directions except when fused with neighbors, thin, translucent, lobed and channelled, the lobes partly free but

usually much fused, at times imbricated, petalloid, the margins uneven and eroded. Color above pale tan, below grayish tan, all parts turning rosy red then brown-red when bruised and many such stained areas are present here and there in most specimens. Surface with several obvious and many obscure zones, in our specimens almost smooth with little or no tomentum.

Stem subcentral, 1.5–5.5 cm. long including the enlarged rooting base, covered with a spongy coat below, and at times all over, at top about 2–4.5 mm. thick, pallid tan at first, then reddish brown, very tough.

Spores (of No. 7025) white, smooth, subspherical with a distinct oil drop, 3–3.4 x 3.3–4μ. Basidia 4-spored, 4.5–5.5μ thick. Hymenium double, 100–136μ (counting both layers). Threads of flesh rather regular in size, 3–4μ thick.

The species is quite variable and has been badly confused, and, no doubt, has been renamed several times. Nobody seems to have described it before from the fresh condition. The dried plants are reddish cartilaginous with ochraceous areas or zones; hymenium light glaucous flesh color. A conspicuous basal mat, which reminds one of some Hydnellums, holds the earth below and suggests *S. floriforme*. Some of our specimens entirely lack this mat and are just like *Stereum elegans* from Brazil, collected by Rev. Rick (see Myc. & Path Coll., Washington, D. C.). Stems vary greatly in length and these collections show that descriptions of *elegans* have been too circumscribed. Lloyd thinks that *Thelephora macrorrhiza* is the same and it seems to us quite likely that *S. floriforme* is also (see Lloyd, Stipitate Stereums, pp. 24, 28, fig. 539).

7025. On ground in deep deciduous woods, August 3, 1923.

7032. On ground in woods, August 3, 1923. The three plants of this collection were gregarious but entirely separate and with long stems.

Stereum craspedium (Fr.) Burt.

Plates 21, 22, 23

Plant massive, 12 cm. high, 10.5 cm. wide, and 7.5 cm. thick, compound, the base completely fused but channelled, expanding upward into partly separate but intricately fused lobes, the lobes more or less concentric, the thick margin upright and fibrous-tomentose; dorsal surface much roughened by fibrous asperities, pallid flesh color. Flesh white; odor unpleasantly meaty, taste after a few seconds disagreeably

acrid. Hymenium rugose-wrinkled all over, pallid flesh color like the dorsal surface, then fleshy buff. Base brownish, ochraceous, tapering into a rooting point about 3.5 cm. long.

Spores white, smooth, subspherical, with a large distinct oil drop, 4.8–5.6 x 5.2–7μ. Hymenium about 75–110μ thick, with long projecting hairs in older portions; basidia clavate, irregular, 6.5μ thick, 35–40μ long with 4 slender straight sterigmata. Threads of flesh closely packed and parallel, undulating, rather regular in size, 3–4.5μ thick; joints few, clamp connections present.

Lloyd thinks that *craspedium* and *aculeatum* are both American representatives of *pallidum*, and it is probable that at least *craspedium* and *pallidum* are the same. *Aculeatum* was found in South Carolina in a swamp by Ravenel. Burt treats all three species as distinct. We do not know of any other species as large as ours, but *aculeatum* is said to reach a width of three inches.

Persoon described *pallidum* as having setulose hymenium. Lloyd says that plants in Persoon's herbarium are not setulose. We have carefully examined our No. 7026 for characters of the hymenium, and think that we have the explanation of these differences of opinion. Much of the hymenium especially toward the upper part is perfectly glabrous and this is the most actively fruiting part. As the hymenium gets older these hairs grow out more and more abundantly, in some places making a very obvious felted-tomentose surface covering the hymenium which is now functionless. In glabrous portions without hairs, the spores are very abundant, piled up together on the surface. Where the hairs have begun to grow out, as shown on plate 23 the spores are far less numerous or soon absent. The hairs may be of any length, in some cases many times longer than shown in the figure.

7026. On the ground in deciduous woods, August 3, 1923.

7094. In decayed wood by a frondose log, August 25, 1923. Center proliferated into several secondary pilei.

UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, N. C.

EXPLANATION OF PLATE

PLATE 23

Figs. 1, 2. Hygrophorus Ravenelii. No. 3590.
Fig. 3. Hygrophorus sciophanus. No. 2791.
Figs. 4, 5. Hygrophorus gomphidioides. No. 4248.
Fig. 6. Hygrophorus luridus. No. 3353.

Fig. 7. Tricholoma niveipes var. australis. No. 76.
Fig. 8. Collybia lentinoides. No. 3755.
Fig. 9. Omphalia lilacifolia. No. 3022.
Fig. 10. Prunulus syringeus. No. 3474.
Fig. 11. Marasmius albiceps. No. 3382.
Fig. 12. Lentinus Micheneri. No. 3527.
Fig. 13. Pholiota terrigena. No. 8364.
Fig. 14. Pluteolus intermedius. No. 8365.
Figs. 15, 16. Stereum elegans. No. 7025.
Figs. 17, 18, 19. Stereum craspedium. No. 7026. Fig. 18 shows semi-diagrammatically the hymenium and the hairs projecting from it.

Figs. 2, 4, 15, 17 × 810; fig. 18 × 500; all others × 1620
Figs. 17 and 18 were drawn by W. C. Coker; all others by Alma Holland

PLATE 15

COLLYBIA LENTINOIDES. No. 3755

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PRUNULUS SYRINGEUS. No. 2740 (ABOVE); No. 2718 (BELOW)

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PLATE 17

LENTINUS MICHENERI. No. 3527

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PLATE 18

PHOLIOTA TERRIGENA. No. 8364

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PLATE 19

PLUTEOLUS INTERMEDIUS. No. 8365

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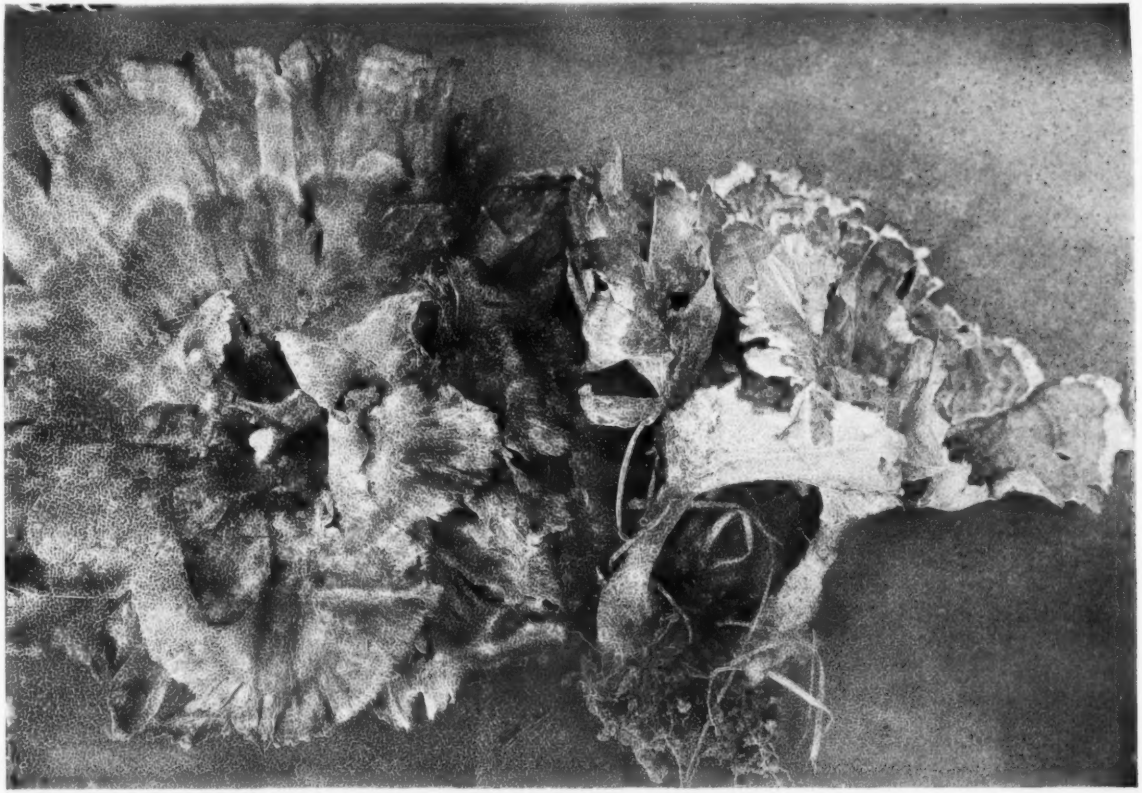

STEREUM ELEGANS. No. 7025
Plate spoiled in developing

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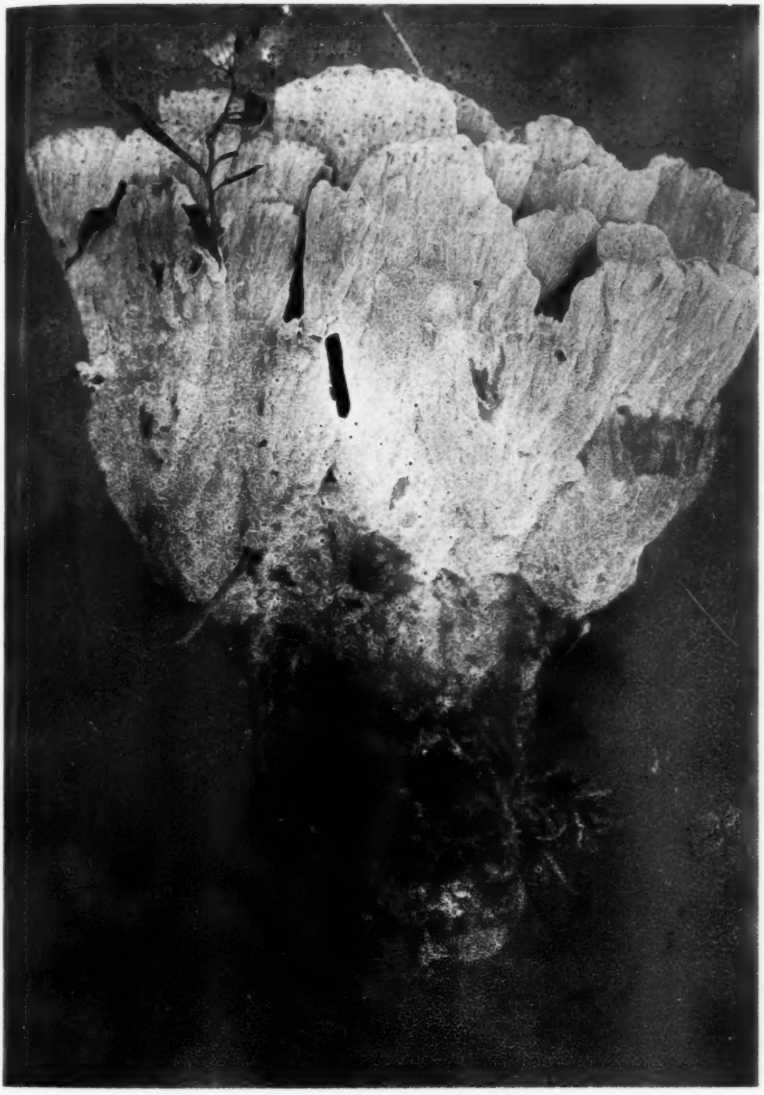
PLATE 21



STEREUM CRASPEDIUM. No. 7026

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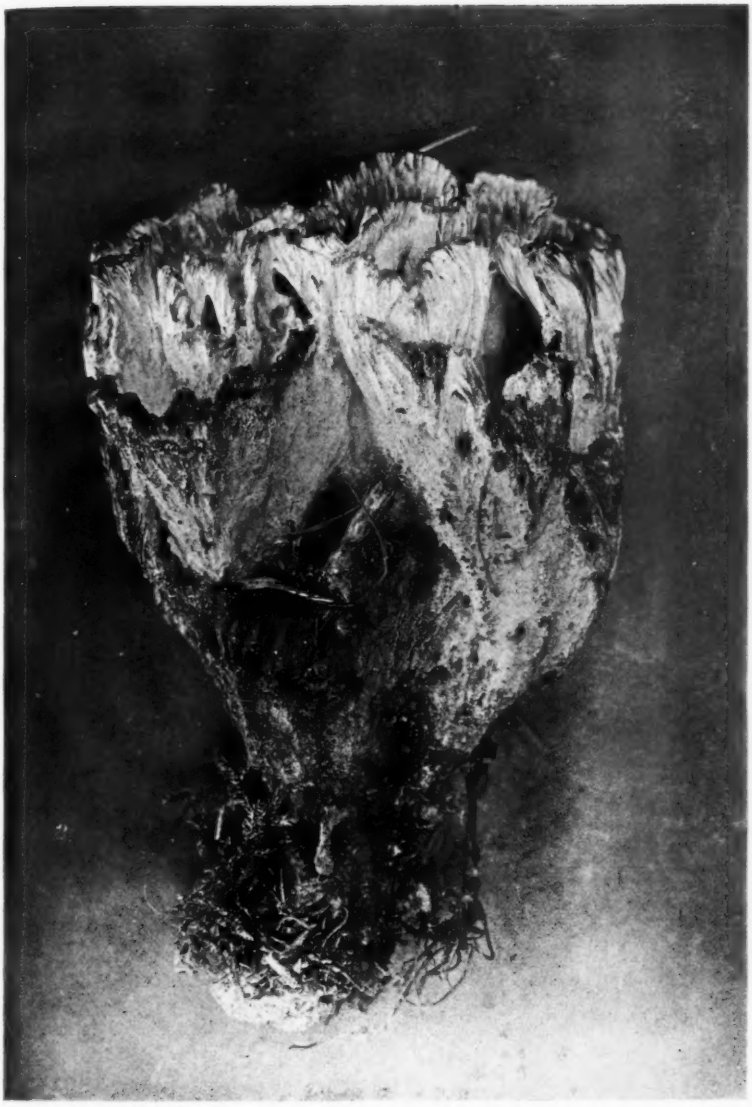
PLATE 22



STEREUM CRASPEDIUM. No. 7026
Taken when partly dried
The minute cracks on the surface are due to defect in the plate

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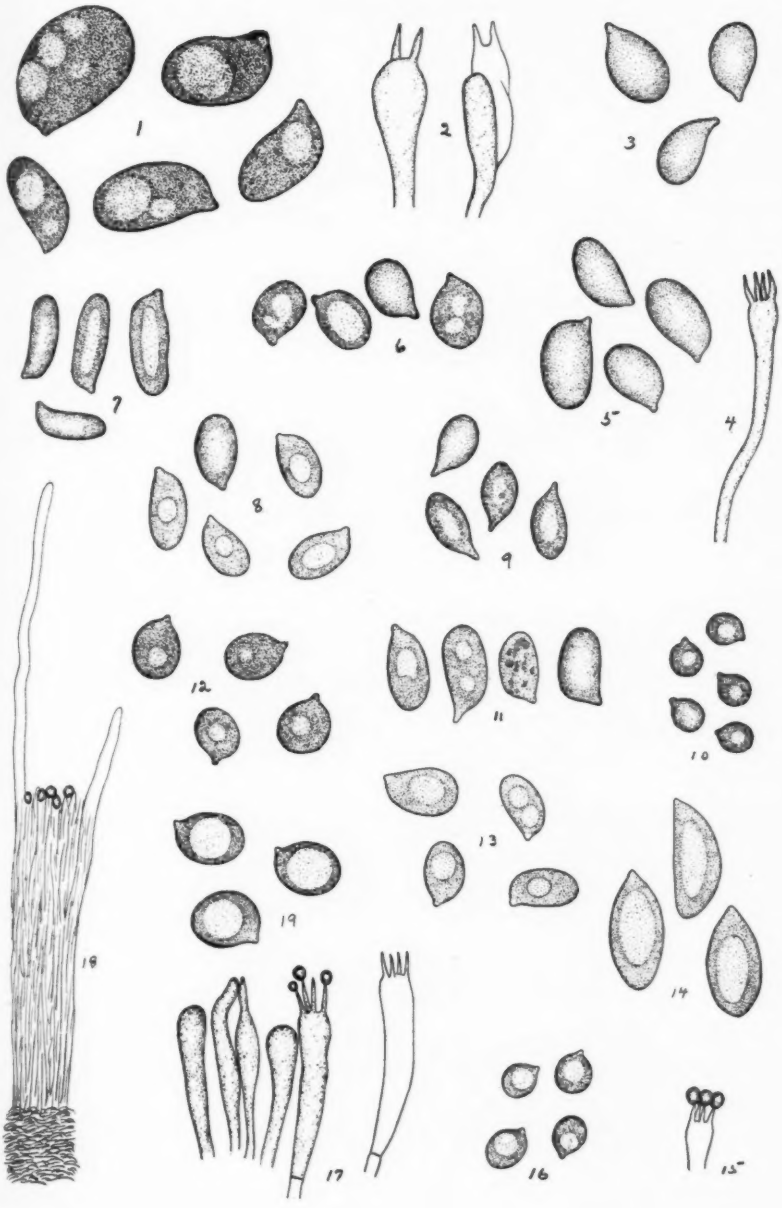
PLATE 23



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